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PB-247 850

ORD PUBLICATIONS SUMMARY

Environmental Protection Agency

September 1975

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EPA-600/9-75-001c

PB 247 850

ABSTRACTS

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TITLES

ORGANIZATIONS

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EXTRAMURAL NUMBERS

ORD PUBLICATIONS SUMMARY

SEPTEMBER 1975

U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

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September 1975

ORD PUBLICATIONS SUMMARY

by

TECHNICAL INFORMATION DIVISION
Office of Monitoring & Technical Support

U.S. Environmental Protection Agency
Office of Research and Development
Washington, D.C. 20460

ATTENTION

On June 29, 1975, the Office of Research and Development (ORD) was officially reorganized. One of the major impacts of this reorganization was to eliminate the former National Environmental Research Center (NERC) management structure for field operation and establish 15 individual laboratories which report directly to headquarters. As a result, the report number prefixes formerly associated with the NERC's have been replaced by one prefix (600) which represents all of ORD technical reports. Any questions arising from this report number change may be directed to the Technical Information Staff, Cincinnati, Ohio 45268, telephone 513/684-8258.

SEE INSIDE OF FRONT COVER FOR "HOW TO ORDER" REPORTS

FOREWORD

This is the third issue of the Office of Research and Development's (ORD's) quarterly **ORD PUBLICATIONS SUMMARY**. This **Summary** is intended to provide a current listing (since July 1973) of ORD's final reports on in-house, grant, contract, and interagency projects. A New Report Abstracts Section is included in the **Summary** to provide brief abstracts of recently printed reports, as well as indices by Title, Performing Organization, Personal Author, Report Number, and Grant, Contract, or Interagency Agreement Number to aid the reader in identifying reports of interest. Instructions on how to order copies of reports are on the inside of the front cover. Comments on how this **Summary** would serve the reader more effectively would be appreciated.

Wilson K. Talley
Assistant Administrator for
Research and Development

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SERIES DESCRIPTION

The U.S. Environmental Protection Agency (EPA) was formed in late 1970 from programs in several executive agencies, i.e., the Department of Health, Education, and Welfare (air pollution, solid waste, radiation, water hygiene, and noise), the Department of the Interior (water pollution), and the Department of Agriculture (pesticide regulation).

In July 1972, EPA's Office of Research and Monitoring (now Office of Research and Development, ORD) established an office-wide series of designations within which each research report would be published. The series can be used to describe the general thrust of EPA research and development and also to aid in identifying the use for each report. The present numbering system and cover color for each report is keyed to this Series Description.

SERIES 1 – ENVIRONMENTAL HEALTH EFFECTS RESEARCH (yellow covers)

Assigned to Series 1 are projects and studies relating to the tolerances of man for unhealthful substances or conditions, generally assessed from a medical viewpoint. In addition to toxicology and other medical specialties, study areas include physiological or psychological studies, and biomedical instrumentation and health research techniques utilizing animals—but always with intended application to human health protection.

SERIES 2 – ENVIRONMENTAL PROTECTION TECHNOLOGY (light blue covers)

Within Series 2 is research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and nonpoint sources of pollution. This work provides the new or improved technology necessary to control and treat pollution sources so that environmental quality standards can be met.

SERIES 3 – ECOLOGICAL RESEARCH (light green covers)

In Series 3 are grouped the investigations on pollution effects on plant and animal species and on materials. Problems are assessed for their long- and short-term influences and studies include formation, transport, and pathway studies to determine the fate of pollutants and their effects. This work provides the basis for setting standards to minimize undesirable changes in living organisms in the aquatic, terrestrial, and atmospheric environments.

SERIES 4 – ENVIRONMENTAL MONITORING (grey covers)

Research conducted to develop new or improved methods and instrumentation for identifying and quantifying environmental pollutants is found in Series 4. Also included are studies to determine the ambient concentrations of pollutants in the environment, or the variance of pollutants as a function of time or meteorological factors, or both.

SERIES 5 – SOCIOECONOMIC ENVIRONMENTAL STUDIES (rust covers)

Included in Series 5 is research devoted to the socioeconomic impact of environmental problems, i.e., recycling and other recovery operations whose emphasis is on monetary incentives and nonscientific realms of legal systems, cultural values, and business systems. Because the interdisciplinary scope of system evaluations and environmental management, these reports are included in Series 5.

SERIES 6 – SCIENTIFIC AND TECHNICAL ASSESSMENT REPORTS (STAR) (dark blue covers)

In Series 6 are assessments of the available scientific and technical knowledge on major pollutants that would be helpful in regulatory decision making or assessments of a major area of completed study. The series is used to present objective evaluations of existing knowledge— evaluations that point out the extent to which it is definitive, the validity of the data on which it is based, and the uncertainties and gaps that may exist. (Most of the reports are multimedia in scope and focus on single media only to the extent warranted.)

SERIES 9 – MISCELLANEOUS (covers of various designs)

Series 9 is used for all reports issued by ORD not applicable to one of the series described above.

USERS' GUIDE

This volume contains an abstract section, a bibliographic section, and six indices. Within each index, reports are cross-referenced to the Bibliographic Section by report number. The bibliographic section and indices are cumulative so you need only refer to the most recent issue for ordering information.

NEW REPORT ABSTRACTS SECTION

This section contains a brief abstract of each recently printed report. An abstract will appear in only one issue so if you need copies of abstracts for reference purposes, you must retain each issue of the **Summary**. If no source is shown in the Bibliographic Section, the report is not yet available. Future issues of the **Summary** will note those reports for which an abstract has been published and indicate the issue in which the abstract appeared; e.g., ---Abstracted 600/9–74–001a---.

BIBLIOGRAPHIC SECTION

In the Bibliographic Section is a numerical listing of reports published since July 1973. The source of each report follows the bibliographic entry, and how to order instructions are given on the inside front cover.

TITLE INDEX

All reports are listed alphabetically by title; "A," "An," and "The" have been dropped from the beginnings of titles.

PERFORMING ORGANIZATION INDEX

This is an alphabetical listing of the organizations which conducted the research reported on in these reports. For grants or contracts, the organization is the grantee or contractor; for in-house reports, the organization is the EPA laboratory or office.

PERSONAL AUTHOR INDEX

The Personal Author Index lists alphabetically all authors of reports contained in the Bibliographic Section.

GRANT, CONTRACT, INTERAGENCY AGREEMENT NUMBER INDEX

This index contains a listing of ORD Contract, Grant, and Interagency Agreement numbers for which a final report has been produced. For each number listed the applicable report number is cross-referenced.

NEW REPORT ABSTRACTS SECTION

600/2–75–029 **PE 1BB043** **ROAP/TASK 21 ASR 08** **GRANT NO. 800354**

Measurements of Active Biomass Concentrations in Biological Waste Treatment Processes BY F. G. Pohland, and S. J. Kany, Georgia Institute of Technology Atlanta, GA

This research was initiated to determine the applicability and limitations of the dehydrogenase test for the measurement of active biomass in biological wastewater treatment processes. Pure culture with *E. coli* and/or heterogeneous culture batch studies were conducted on a variety of substrates including glucose, galactose, sucrose, alanine, acetic acid, and selected industrial wastewaters. Also conducted were continuous aerobic or anaerobic culture studies with and without solids recycle. Dehydrogenase activity was monitored along with other parameters including plate count, Coulter Counter enumeration, adenosine triphosphate (ATP), and suspended solids to provide comparative and completary information on the biomass concentration. Dehydrogenase activity was a very sensitive and accurate measure of active biomass throughout the growth phases especially during endogenous growth but showed limitations with the nutrient deficient cultures. The correlation between dehydrogenase activity and suspended solids was constant at varying retention times, or at all growth rates with or without solids recycle. Consequently, a standard curve could be developed for given wastewaters by operating the measurement of active biomass and thereby effectively controlling the biological process. The measurement of ATP was also a reliable new technique for measurement of active biomass except more study on the extraction method is required as well as investigations on the change of the correlation with suspended solids with the change of growth rate. The technique for dehydrogenase activity measurement is simple, less costly and gives more reliable and interpretable results. EPA CONTACT: Lewis, R. F. 513–684–8467

600/2–75–030 **PE 1BB043** **ROAP/TASK 21 ASO 46** **GRANT NO. 11060 FRQ**

Hatfield Township, Pennsylvania, Advanced Waste Treatment Plant BY T. W. Greenlund, and F. R. Gaines, Hatfield Township Municipal Authority Colmar, PA

The Hatfield Township, Pennsylvania, Water Pollution Control Plant was designed to encompass primary chemical treatment, secondary combined activated sludge and nitrification facilities, tertiary chemical tube clarification and mixed media filtration. The operation of the facility demonstrated that the use of flow equalization facilities improves plant operations by reducing and standardizing chemical concentrations. Phosphorus is removed efficiently in a combined primary-tertiary phase with operations personnel having the flexibility to optimize each process. Lime feed control by pH is easily accomplished, although recirculation of primary sludges is not always necessary. Tube clarifiers and mixed media filters combine to produce a highly polished effluent. Nitrification was observed to some extent in this modified facility, however, it was extremely difficult to control. EPA CONTACT: Lewis, R. F. 513–684–8467

600/2–75–031 **PE 1BB043** **ROAP/TASK 21 ASR 38** **GRANT NO. 802003**

Actinomycetes of Sewage-Treatment Plants BY H. A. Lechevalier, Rutgers University New Brunswick, NJ

In some sewage-treatment plants of the activated sludge type, a thick foam may be formed at the surface of the secondary aeration and settling tanks. Such foams have often been found to be rich in actinomycetes. This report covers the work done on this problem between April 1971 and May 1974. Over 250 strains of actinomycetes have been isolated from foams or activated sludge from 19 different sewage-treatment plants located in 8 states. The actinomycete most commonly associated with foams is a previously undescribed *Nocardia* which has been given the name *N. amarae*. It has been demonstrated experimentally in the laboratory that *N. amarae* may cause the kind of foam observed in the plants. Factors affecting the growth of *N. amarae* have been studied and a method of control of the foam by addition of digester supernatant to the activated sludge is proposed. EPA CONTACT: Lewis, R. F. 513–684–8467

600/2–75–032 **PE 1BB043** **GRANT NO. 17050 DFJ**

Bioflocculation and the Accumulation of Chemicals By Floc-Forming Organisms BY P. R. Dugan, Ohio State University Columbus, OH

Several floc-forming bacteria were isolated from polluted water by this and other laboratories. All organisms studied produced extracellular polymer fibrils that were related to slime matrix and flocculation. The extracellular polymers have high adsorption capacity for: soluble metal and other mineral ions, soluble organic nutrients (BOD), soluble toxic organics, insoluble mineral particles and insoluble organic particulates. The bacteria remove BOD by physical adsorption as well as by oxidative metabolism and can convert oxygen demanding organics to more extracellular polymer. Production of polymer can be stimulated nutritionally to yield amounts that have waste treatment – pollution abatement potential on a commercial scale. The relationship of bioflocculation to waste treatment and lake eutrophication is discussed and the basic mechanism of bioflocculation is considered. Biochemical activities of individual floc-forming cells is examined because of its relevance to polymer synthesis. Taxonomy of floc-formers is also considered in relationship to biochemical activities. EPA CONTACT: Chambers, C. W. 513–684–8328

NEW REPORT ABSTRACTS SECTION

600/2-75-036 PE 1BC611 IN-HOUSE PROJECT

Alternative Septage Treatment Method: Lime Stabilization/ Sand-Bed Dewatering BY W. A. Feige, E. T. Oppelt, and J. F. Kreissl, Municipal Environmental Research Laboratory, EPA Cincinnati, OH

Approximately 5 billion gal (18,927,000 cubic meters) of septage must be annually disposed of in the United States, a volume that is nearly equal to that of undigested raw and secondary municipal sludges. Few desirable methods exist for disposing of the sludge that is periodically pumped from septic tanks. This report describes the results obtained from a pilot study of one alternative septage treatment method-lime stabilization followed by covered sand-bed dewatering. The study was conducted in two phases. Phase I (4 months) consisted of the general, chemical, and biological characterizations of the incoming septage. Attempts were made to thicken the material via stirring, polyelectrolyte addition, and lime addition. Phase II (9 months) concerned itself with the application of lime septage onto covered sand beds. Four experimental runs were conducted to assess the feasibility of such an approach. The septage was limed to pH 10.5, 11.0, and 11.5 and applied at 8-in (20.3-cm) depths. Underdrainage and cake characteristics were monitored and practical sand-bed application rates were determined. A materials balance of chemical constitutents around the system was made. A cost estimate for the treatment of septage at small treatment plants via this method is included. EPA CONTACT: Feige, W. A. 513-684-8231

600/2-75-037 PE 1AB013 ROAP/TASK 21 ACZ 03 CONTRACT NO. 68-02-0650

Test Evaluation of Cat-Ox High Efficiency Electrostatic Precipitator BY E. M. Jamgochian, N. T. Miller, and R. Reale, Mitre Corporation McLean, VA

The report gives results of a test program to measure the performance of the high efficiency Research-Cottrell electrostatic precipitator (ESP) located at the Wood River Power Station, East Alton, Illinois. The overall efficiency of the ESP was measured as a function of steam generator and ESP operating conditions. Of particular interest was the efficiency of the ESP as a function of particle size over the range from 0.01 to 5 micrometer. In addition, fly ash resistivity, gas concentrations, coal analyses, and fly ash analyses were determined. The measured results were compared with those generated by an idealized computer simulation model. EPA CONTACT: Chatlynne, C. J. 919-549-2915

600/2-75-042 PE B458 ROAP/TASK 21 BVJ 34 CONTRACT NO. 68-02-1319

Control of Hydrocarbon Emissions From Petroleum Liquids BY C. E. Burnklin, E. C. Cavanaugh, J. C. Dickerman, S. R. Fernandes, and G. C. Wilkins, Radian Corporation Austin, TX

The report is a state-of-the-art review of the availability and application of technology for the control of hydrocarbon emissions to the atmosphere from facilities for the production, refining, and marketing of liquid petroleum fuels. The review includes: (1) identification of major hydrocarbon emission sources within the petroleum industry and the quantity of such source emissions, (2) review of existing hydrocarbon emission control technology and the extent of its application by the petroleum industry, and (3) identification of hydrocarbon emission sources within the petroleum industry for which control techniques are neither available nor widely applied. EPA CONTACT: Lorenzi, L. 919-549-2851

600/4-75-008 PE H120 IN-HOUSE PROJECT

Radio Chemical Methodology for Drinking Water Environmental Monitoring and Support Laboratory, EPA Cincinnati, OH

A laboratory manual of radiochemical procedures has been compiled and edited for use in the analysis of specific radionuclides in drinking water; nuclides for whom the Environmental Protection Agency recommended maximum contaminant levels in its interim drinking water standards. In addition to gross activity analyses, the procedures for (134/137)Cs, (131)I, (226/228) Ra, (89/90) Sr, (3)H and (40)K were evaluated by replicate testing to determine the method capabilities and minimum detection levels. The results, which indicate that the sensitivity of these procedures is at least a factor of ten greater than the present recommended limits, are given in the Appendix. Also appended is information on reagent preparation and suggested sources for purchasing special equipment. [illegible] CONTACT: Krieger, H. 513-684-3232

NEW REPORT ABSTRACTS SECTION

600/5-75-012 PE 1HA098 ROAP/TASK 21 BAX 02 GRANT NO. 803056

Minimum Standards For Quality of Life BY O. W. Markley, and M. D. Badgley, Stanford Research Institute Menlo Park, CA

This study addresses a number of issues of concern under various sectors of man's environment. For each issue three types of available information are compiled: (1) public laws and other less formal understandings that set minimum standards, (2) objective data that reflect how well those standards are being met, and (3) subjective data that reflect how people feel about that aspect of the quality of their life. Man's needs are grouped into two major areas—(1) *basic needs*, including minimal life conditions necessary to meet physiological and security needs, and (2) *higher needs*, to include social needs, ego needs, and a need for self-fulfillment. Standards are being categorized under each major need area, according to four levels of concern, arranged in a heirarchical order: First, the existing welfare concern—a statement of the threshold level; second, security—standards insuring the welfare for all persons; and finally, ability to influence—standards that allow individuals to influence threshold levels and their own access to welfare. In addition to identifying the range of minimal standards that have been codified, this study will: (1) assess the various ways in which these standards apply to real conditions (e.g., social indicators and additudinal data), (2) identify 'gaps' and inconsistencies in existing standards that need to be remedied, and (3) analyze the policy implications and effectiveness of using this approach as a way to describe and improve quality of life in the United States.

600/5-75-013 PE 1HA095 ROAP/TASK 21 ART 11 IAG NO. IAG-148

Secondary Impacts of Transportation and Wastewater Investments: Research Results BY S. E. Bascom, K. G. Cooper, M. P. Howell, A. C. Makrides, and F. T. Rabes, Environmental Impact Center Newton, MA

This report is the second of a two-part research study. The first report involved an extensive review of previous research pertaining to secondary effects of highways, mass transit, wastewater treatment and collection systems, and of land use models which might be utilized to project secondary environmental effects. The report is published under the title: *Secondary Impacts of Transportation and Wastewater Investments + Review and Bibliography* (EPA No. 600/5-75-002, January, 1975). The second report, presents, in this publication, the results of original research on the extent to which secondary development can be attributed to highways and wastewater treatment and collection systems, and what conditions under which causal relations appear to exist. Case studies of recent development trends were made in four metropolitan regions: Boston, Massachusetts, Denver, Colorado, Washington, D.C., and MinneapolisSt. Paul, Minnesota. Data for the four metropolitan regions were analyzed using econometric techniques and simulation modeling. The data tape (TMP 243) is stored with Optimum Systems Incorporated, Washington, D.C. This report consists of four sections: an Introduction and Summary of Findings; a technical documentation of case studies and econometric analysis; an evaluation of the Findings and Suggestions for Further Research; and Appendices summarizing the dynamic model and its application. EPA CONTACT: Scherer, R.

600/5-75-015 PE 1HC619 CONTRACT NO. 68-01-2232

Quantitative Method for Effluent Compliance Monitoring Resource Allocation BY A. I. Cohen, Y. Bar-Shalom, W. Winkler, and G. P. Grimsrud, Systems Control, Inc. Palo Alto, CA

This report develops and demonstrates a quantitative method for the preliminary design of effluent standard surveillance systems. The principal output of the report is a procedure to be used in the state or EPA water quality programs to determine the frequency of effluent compliance monitoring visits. The procedure allocates compliance monitoring budgetary resources so as to minimize environmental damage. It utilizes a statistical model of the effluents that is obtained from selfmonitoring and compliance monitoring data. The procedure is demonstrated on an example river basin using data supplied by the State of Michigan. EPA CONTACT: Lewis, D.

650/2-75-001a PE 1AB014 ROAP/TASK 21 ADF 03 CONTRACT NO. 68-02-0648

Assessment of Catalysts for Control of NOx from Stationary Power Plants, Phase I, Volume I – Final Report TRW Systems Group Redondo Beach, CA

The report summarizes results of investigations to assess the technical and economic feasibility of utilizing catalytic processes in power plant nitrogen oxide (NO_x) emission abatement. The investigations involved a literature survey and the development of a data bank on pertinent articles and patents, experimental screening tests on selected promising catalysts, and preliminary design and cost analysis of candidate processes adapted to new and/or existing power plants. The stepwise selection and prioritization of catalysts indicated that at least two types of catalytic NO_x control processes should be adaptable to power generating plants: selective reduction of NO_x with ammonia on non-noble metal catalysts; and simultaneous nonselective reduction of NO_x and sulfur oxides with coal-derived reductants on non-noble metal catalysts.

The report summarizes results of investigations to assess the technical and economic feasibility of utilizing catalytic processes in power plant nitrogen oxide (NO_x) emission abatement. The investigations involved a literature survey and the development of a data bank on pertinent articles and patents, experimental screening tests on selected promising catalysts, and preliminary design and cost analysis of candidate processes adapted to new and/or existing power plants. The stepwise selection and prioritization of catalysts indicated that at least two types of catalytic NO_x control processes should be adaptable to power generating plants: selective reduction of NO_x with ammonia on non-noble metal catalysts; and simultaneous nonselective reduction of NO_x and sulfur oxides with coal-derived reductants on non-noble metal catalysts. EPA CONTACT: Wingo, J. B.

NEW REPORT ABSTRACTS SECTION

650/2-75-001b PE 1AB014 ROAP/TASK 21 ADF 03 CONTRACT NO. 68-02-0648

Assessment of Catalysts for Control of NOx from Stationary Power Plants, Phase I, Volume II – Data Bank Citation Indices TRW Systems Group Redondo Beach, CA

The report summarizes results of investigations to assess the technical and economic feasibility of utilizing catalytic processes in power plant nitrogen oxide (NO_x) emission abatement. The investigations involved a literature survey and the development of a data bank on pertinent articles and patents, experimental screening tests on selected promising catalysts, and preliminary design and cost analysis of candidate processes adapted to new and/or existing power plants. The stepwise selection and prioritization of catalysts indicated that at least two types of catalytic NO_x control processes should be adaptable to power generating plants: selective reduction of NO_x with ammonia on non-noble metal catalysts; and simultaneous nonselective reduction of NO_x and sulfur oxides with coal-derived reductants on non-noble metal catalysts. EPA CONTACT: Wingo, J. B.

650/2-75-002 PE 1AB012 ROAP/TASK 21 ADL 22 GRANT NO. 800042

Influence of Fiber Characteristics on Particulate Filtration Textile Research Institute Princeton, NJ

The report gives results of an evaluation of the influence of five fiber parameters (cross-sectional shape, linear density, surface roughness, crimp, and staple length) on the filtration performance of model nonwoven fabrics made from the fibers. Nonwoven fabrics made from 32 polyester fiber samples were used to filter fly-ash particles from a stream of air. Filter performance was assessed by measuring: pressure drop across the filter, collection efficiency, and particle size distribution. Statistically, at 95% confidence: efficiency was improved by using trilobal (rather than round cross-section) fibers with no detrimental effect on drag; efficiency and drag were improved by using crimped (rather than uncrimped) fibers; and efficiency was improved by using 3 (rather than 6) denier fibers, but at the cost of greater drag. These efficiency improvements were especially pronounced for fine particles (approximately 2.5 microns). Non-statistically, except for epitropic fibers with very rough carbon-embedded surfaces, rougher fibers appeared more efficient in removing fine particles. Applying d.c. voltages to 100% non-conducting polyester filters showed considerable increases in efficiency; again, no such effects were seen with polyester filters incorporating 50% epitropic fibers. EPA CONTACT: Turner, J. H.

650/2-75-006 PE 1AB013 ROAP/TASK 21 ACY 31 CONTRACT NO. 68-02-0023

Theoretical and Experimental Study of the Lime/Limestone Wet Scrubbing Process Radian Corporation Austin, TX

The report describes results of technical efforts in several areas relating to the development of the lime/limestone wet scrubbing process. It reviews a portion of the test plan for EPA's prototype test facility. It describes laboratory studies of key reaction steps, including lime and limestone dissolution rates and calcium sulfite and sulfate precipitation rates. It describes engineering and chemistry support for EPA-contracted pilot unit studies, including test program design, on-site sampling and chemical analysis of test samples, as well as engineering analysis of test results. It reports on chemical analysis support, including assistance with the analytical data system at EPA's prototype test facility. EPA CONTACT: Jones, J. W.

650/2-75-008 PE 1AA010 ROAP/TASK 26 AAM CONTRACT NO. 68-02-0660

In-Stack Transmissometer Evaluation and Application to Particulate Opacity Measurement Fecker Systems, Owens-Illinois, Inc. Pittsburgh, PA

A laboratory and field testing program has been carried out to investigate the performance of a commercially available transmissometer as an in-situ monitor of industrial exhaust stack emissions. During the laboratory phase the characteristics and operating parameters of the instrument were measured and the system calibrated for field use. The transmissometer was mounted for a period of at least 30 days at each of three different sites. At each site concurrent plume opacity measurements were made by the telephotometry of contrasting targets through the plumes for comparison to the in-stack readings with the transmissometer. Additional plume measurements were made at one of the sites by direct telephotometry of a lamp behind the plume. A one-to-one correlation between in-stack and plume opacity was observed at one site but data obtained at the other two sites were limited to much narrower ranges of emission levels although there was also a one-to-one correlation within the narrower range at one of the other sites. The transmissometer performed well at all three sites. EPA CONTACT: Conner, W. D.

NEW REPORT ABSTRACTS SECTION

650/2-75-009 PE 1AB012 ROAP/TASK 21 ADJ 49 CONTRACT NO. 68-02-0268

Fabric Filter Cleaning Studies GCA Corporation Bedford, MA

The report gives results of a detailed study of fabric filter cleaning mechanisms. A highly instrumented, pilot plant system was built to operate as a single- or multiple-bag unit for the investigation of cleaning by mechanical shaking, pulse jet air, and reverse flow air. Four woven bag types (cotton and Dacron) and two felt bag types (wool and Dacron) were evaluated with resuspended fly ash and talc dusts. Analysis of cleaning by both mechanical shaking and pulse jet air indicated that the tensile forces generated by bag acceleration were the main cause of dust removal; aerodynamic re-entrainment played only a minor role. Residual fabric drag, fabric holding capacity, and dust penetration characteristics were predictable, based on such cleaning parameters as shaking frequency, amplitude, pulse jet pressure, and rate of pressure rise. Based on inlet concentration of 3–10 gr/cu ft, effluent cotcentration for mechanically shaken, woven fabrics ranged from 10 to the minus 7th power to 0.001 gr/cu ft, in contrast to 0.001–0.01 gr/cu ft for felted media cleaned by pulse jet air. Effluent concentrations for both systems decreased significantly as filtration progressed. Caution should be exercised before extrapolating test results to dust/fabric combinations other than those investigated, until more data is available. EPA CONTACT: Harmon, D. L.

650/2-75-010a PE 1AB013 ROAP/TASK 21 ACY 30 IN-HOUSE PROJECT

Sulfur Oxide Throwaway Sludge Evaluation Panel (SOTSEP), Volume I: Final Report – Executive Summary Control Systems Laboratory, EPA Research Triangle Park, NC

The report gives results of an intermedia evaluation of the environmental and economic factors associated with disposal or utilization of sludge from nonregenerable flue gas desulfurization processes. The evaluation was conducted in the context of alternate sulfur oxide control techniques; existing and anticipated air, solid waste, and water standards; and other major influences on the potential generation of sludge, its disposal, and the magnitude of potential environmental problems associated with its disposal. Volume I gives a concise review of findings and technical recommendations, as well as details of each specific study category. Volume II gives a comprehensive discussion of each study area and includes backup information and references for the Volume I Summary section. EPA CONTACT: Princiotta, F. T.

650/2-75-010b PE 1AB013 ROAP/TASK 21 ACY 30 IN-HOUSE PROJECT

Sulfur Oxide Throwaway Sludge Evaluation Panel (SOTSEP), Volume II: Final Report – Technical Discussion Control Systems Laboratory, EPA Research Triangle Park, NC

The report gives results of an intermedia evaluation of the environmental and economic factors associated with disposal or utilization of sludge from nonregenerable flue gas desulfurization processes. The evaluation was conducted in the context of alternate sulfur oxide control techniques; existing and anticipated air, solid waste, and water standards; and other major influences on the potential generation of sludge, its disposal, and the magnitude of potential environmental problems associated with its disposal. Volume I gives a concise review of findings and technical recommendations, as well as details of each specific study category. Volume II gives a comprehensive discussion of each study area and includes backup information and references for the Volume I Summary section. EPA CONTACT: Princiotta, F. T.

650/2-75-011 PE 1AB013 ROAP/TASK 21 ADD 25 IAG NO. IAG-D4-0454

Sulfur and Nitrogen Balances in the Solvent Refined Coal Process U.S. Department of the Interior Washington, DC

The report gives results of an exact elemental balance study of the Solvent Refined Coal (SRC) process that was conducted with the laboratory reactor to determine the fate of sulfur and nitrogen in the SRC process. The work was performed in late 1972 as part of a normal experiment with Kentucky No. 9 high volatile B bituminous coal and a blend of processed anthracene oils under 1000 psig hydrogen presminous coal and a blend of processed anthracene oils under 1000 psig hydrogen pressure. A variety of technique studies had been made in preparation, such as investigation of the effects of sample size on analysis and methods of handling all samples of input and output material for maximum recovery and representative composition. Accounting for carbon and hydrogen was accurate, for sulfur good, and for nitrogen poor. A detailed comparison of conventional Kjeldahl and Dumas analytical results for nitrogen in coal and solid products revealed that input nitrogen is not fully reported by Kjeldahl and that sample size affects nitrogen results reported by Dumas. Nitrogen analysis needs further investigation. The study forced review of sampling and handling techniques as well, with salutary results in laboratory work. EPA CONTACT: Lorenzi, Jr., L.

NEW REPORT ABSTRACTS SECTION

650/2–75–012 PE 1AB014 ROAP/TASK 21 ADG 89 GRANT NO. 802366

Analysis of Test Data for NOx Control in Gas and Oil-Fired Utility Boilers Aerospace Corporation El Segundo, CA

The report describes analyses of a large number of emissions, operating conditions, and boiler configuration data from full-scale, multiple-burner electric utility boilers using natural gas and low-sulfur oil fuels. Objectives of the study included: evaluation of the effects of combustion modifications on NO_x emissions, in fundamental combustion terms; evaluation of techniques for further reductions in NO_x emissions; and determination and substantiation of general mechanisms for observed combustion and flame stability problems. The report includes: (1) a discussion of the major combustion process modifications resulting in NO_x emission reductions due to two-stage combustion, burners out-of-service, combustion air temperature reduction, load reduction, and excess air variations; (2) estimates of NO_x minima achievable in the boilers studied with current hardware; (3) estimates of most probable longer term hardware and operating condition modifications likely to yield ultimate NO_x reductions with these fuels; (4) identification and verification of general mechanisms for the combustion and flame instabilities observed; and (5) a list of all of the hardware configurations, operating conditions, and NO_x, CO, O_2 and CO_2 emissions data for 428 tests in eight full-scale, multiple-burner, face-fired electric utility boilers using natural gas and low sulfur oil fuels. EPA CONTACT: Hall, R. E.

650/2–75–016 PE 1AB012 ROAP/TASK 21 ADL 34 CONTRACT NO. 68–02–1308

Symposium on Electrostatic Precipitators for the Control of Fine Particles Southern Research Institute Birmingham, AL

The papers in these proceedings, prepared by investigators active in research on electrostatic precipitators (ESPs), describe recent advances in ESP technology, especially in the control of fine particles (those less than 1–2 micrometers in diameter) in industrial emissions. Data such as fractional collection efficiency measurements are presented that can be used to help define the capability of ESPs for the control of fine particles. Techniques for the sizing and design of ESPs, including a theoretically based mathematical model of ESP performance, and the selection of power supplies to improve performance and reliability are discussed. Methods for combatting the problem of collection high-resistivity fly ash from the combustion of low-sulfur coal that are described include the operation of ESPs at both lower and higher than usual flue-gas temperatures, and the conditioning of fly ash by injection of sulfur trioxide, ammonia, or sulfamic acid into the flue gas. Performance data are presented on ESPs for the control of fumes from kraft pulp mill recovery boilers and on wet ESPs in aluminum reduction plants and other industrial applications. Research on electrostatic and radiation charging of fine particles, on corona quenching by particle space charge, and on charged-droplet scrubbers is discussed. EPA CONTACT: Drehmel, D. C.

650/2–75–017 PE 1AB014 ROAP/TASK 21 BCC 42 CONTRACT NO. 68–02–1308

Identification and Characterization of the Use of Mixed Conventional and Waste Fuels M. W. Kellogg Company Houston, TX

The report gives results of a study to determine types of mixed and waste fuels and the extent of their usage in stationary combustion equipment. Where possible, pollutant emission levels resulting from combustion of these fuels have been determined. Industries surveyed included utilities, petroleum refineries, petrochemical, chemical processing, glass, cement, and textiles. Of the industries surveyed, about 70% of the refineries, 45% of the utilities, 20% of the cement, glass, and textile manufacturers, and 10% of the petrochemical and chemical processing plants have reported using mixed fuels to some extent. EPA CONTACT: Lachapelle, D. G.

650/2–75–019a PE 1AB015 ROAP/TASK 21 AXM 11 CONTRACT NO. 68–02–1320

Source Assessment Prioritization of Air Pollution from Industrial Surface Coating Operations Monsanto Research Corporation Dayton, OH

The report summarizes the results of a program to gather and analyze background information and technical data to establish a data base for the purpose of prioritizing atmospheric emissions from industrial surface coating operations, excluding automobile and architectural painting. The report contains a prioritized listing of industrial sources of air pollution for each of ten product-type categories. Additionally, surface coating processes are discussed, together with applicable emission control technology. EPA CONTACT: Denny, D. A.

650/2–75–020 PE 1AB013 ROAP/TASK 21 ACX AE CONTRACT NO. 68–02–0636

Continuous Measurement of Total Gas Flowrate from Stationary Sources TRW Systems Group Redondo Beach, CA

The report gives results of an evaluation of hardware and techniques for the continuous measurement of the total gas flowrate from stationary sources. The work involved formulating operating specifications, evaluating commercially available velocity sensors and measurement techniques, and a field demonstration of the most promising techniques. The accuracy of several known mapping techniques for circular ducts was verified as being acceptable, and new mapping techniques were successfully developed for flows in rectangular ducts. Several off-the-shelf velocity sensors were found to be acceptable for use in the proposed stack-type environment. The field demonstration showed that the hardware and techniques used were adequate. EPA CONTACT: Kuykendal, W. B.

NEW REPORT ABSTRACTS SECTION

650/2–75–021 PE 1AB013 ROAP/TASK 21 ADE 29 CONTRACT NO. 68–02–1325

Distributions of Industrial and Commercial-Institution External Combustion Boilers Research Triangle Institute Research Triangle Park, NC

The report gives results of a study of some characteristics of industrial and commercial-institutional external combustion boilers. The results are presented as tables of joint distributions within various boiler, plant, stack, and fuel characteristics, along with marginals and cumulative marginals and some descriptive graphs. Inputs were provided from EPA's National Emissions Data System (NEDS) data base. Preceding the distributions and marginals, there is a description of the method of their production; following the distributions are a logical flow chart and listings of the computer programs that produced the distributions and graphs. EPA CONTACT: Chatlynne, C.

650/2–75–022 PE 1AB012 ROAP/TASK 21 ADM 11 CONTRACT NO. 68–02–0273

Andersen Filter Substrate Weight Loss Southern Research Institute Birmingham, AL

The report gives results of an investigation, under laboratory conditions, to determine the extent and cause of weight losses first noticed in field situations on Andersen impactor fiberglass substrates. The investigation results indicated that, if performed carefully throughout, sample acquisition should result in a weight loss of no more than 0.20 mg per stage. Such a loss is not of major consequence when more than 2–3 mg is collected on a stage; however, it could represent a serious error at less than 2–3 mg. Incomplete drying and careless handling were found to be the major sources of weight loss. EPA CONTACT: Harris, D. B.

650/2–75–023 PE 1AB014 ROAP/TASK 21 BCC GRANT NO. 802499–01

Evaluation of Prechamber Spark Ignition Engine Concepts Aerospace Corporation El Segundo, CA

The report reviews the performance, emission, and operational characteristics of prechamber (or divided chamber) spark ignition engine concepts, including an analysis and evaluation of the applicability of these concepts to new automotive and stationary engines and retrofit installations. Relative to conventional automotive engines, prechamber engines exhibit very low carbon monoxide emissions accompanied by some reduction in the emission of nitrogen oxides. However, the hydrocarbon emission from prechamber engines is similar to that of conventional engines employing non-catalytic emission control systems, indicating a need for aftertreatment devices such as lean thermal reactors or catalytic converters. The fuel consumption of vehicles equipped with prechambers is similar to or slightly better than that of equivalent conventional vehicles at comparable levels of emission control. EPA CONTACT: Wasser, J. H.

650/2–75–024a PE 1AB012 ROAP/TASK 21 ADL 04 CONTRACT NO. 68–02–1487

Pentapure Impinger Evaluation GCA Corporation Bedford, MA

The report gives results of testing a novel spray scrubber, the Pentapure (Purity Corporation, Elk Grove Village, Illinois), as part of a program to identify novel, high efficiency, fine particle control devices. Emissions from a gray iron foundry were tested after they had exited from a spray cooling chamber. Their mass median aerodynamic diameter was 0.5 micrometers, as determined with cascade impactor samples. Inlet and outlet samples were taken with cascade impactors and with total mass measuring sampling trains. Total mass efficiency was found to be 10.0 + or – 2.5% on this fine dust. The particle aerodynamic diameter for which the efficiency would be 50% was estimated to be between 2 and 4 micrometers, determined from cascade impactor analysis and from theoretical performance predictions. The pressure drop across the Pentapure scrubber was 1500 N/sq m (6 in. H_2O) and the measured efficiencies corresponded to those expected from venturi scrubbers having somewhat less pressure drop. The Pentapure scrubber is not an efficient fine particle collector. EPA CONTACT: Harmon, D. L. 919–549–2557

650/2–75–026a PE 1AB015 ROAP/TASK 21 AFA 106 CONTRACT NO. 68–02–1406

Testing of a Molecular Sieve Used to Control Mercury Emission From A Chlor-Alkali Plant, Volume I Engineering-Science, Inc. McLean, VA

The report gives results of performance testing for mercury emission control of a Union Carbide PuraSiv Hg adsorbent unit currently used to control mercury emissions from the by-product hydrogen stream of the mercury-cell chlor-alkali production facility of Sobin ChlorAlkali in Orrington, Maine. Adsorber inlet and outlet streams were sampled simultaneously during five consecutive 24-hour adsorption cycles, eight sampling runs per cycle, in accordance with a modified version of the EPA Reference Method 102. Inlet mercury concentrations were stable at 6 to 10 mg/normal cu m. Outlet mercury concentrations of 0.5 and 3.5 mg/normal cu m were approached at the beginning and end of each adsorption cycle, respectively. This occurrence was due to the PuraSiv unit's operation at nearly 150% of design capacity of 49.6 normal cu m/min. If operated at design capacity, the estimated outlet mercury concentrations from the PuraSiv Hg unit would average 0.2 micrograms/normal cu m throughout each adsorption cycle, representing a 99.9% collection efficiency. EPA CONTACT: Wooldridge, E. J. 919–549–2547

NEW REPORT ABSTRACTS SECTION

650/2-75-026b PE 1AB015 ROAP/TASK 21 AFA 106 CONTRACT NO. 68-02-1406

Testing of a Molecular Sieve Used to Control Mercury Emission From A Chlor-Alkali Plant, Volume II – Appendices Engineering-Science, Inc. McLean, VA

The report gives results of performance testing for mercury emission control of a Union Carbide PuraSiv Hg adsorbent unit currently used to control mercury emissions from the by-product hydrogen stream of the mercury-cell chlor-alkali production facility of Sobin ChlorAlkali in Orrington, Maine. Adsorber inlet and outlet streams were sampled simultaneously during five consecutive 24-hour adsorption cycles, eight sampling runs per cycle, in accordance with a modified version of the EPA Reference Method 102. Inlet mercury concentrations were stable at 6 to 10 mg/normal cu m. Outlet mercury concentrations of 0.5 and 3.5 mg/normal cu m were approached at the beginning and end of each adsorption cycle, respectively. This occurrence was due to the PuraSiv unit's operation at nearly 150% of design capacity of 49.6 normal cu m/min. If operated at design capacity, the estimated outlet mercury concentrations from the PuraSiv Hg unit would average 0.2 micrograms/normal cu m throughout each adsorption cycle, representing a 99.9% collection efficiency. EPA CONTACT: Wooldridge, E. J. 919-549-2547

650/2-75-027a PE 1AB013 ROAP/TASK 21 ADB 09 CONTRACT NO. 68-02-0605

Fluidized Bed Combustion Process Evaluation (Phase I – Residual Oil Gasification/Desulfurization Demonstration at Atmospheric Pressure) Volume I – Summary Westinghouse Research Laboratories Pittsburgh, PA

This volume of the report summarizes results of an evaluation of the atmospheric-pressure fluidized bed residual oil gasification/ desulfurization process, a process referred to by its inventor (Esso Research Centre, Abingdon, England) as the chemically active fluidized bed (CAFB) process. The CAFB produces a clean, low heating value fuel gas for firing in a conventional boiler. The integrated process, previously operated successfully in a 750 kW pilot plant unit, has demonstrated the ability to meet environmental emission standards for sulfur oxides, nitrogen oxides, and particulates. Work carried out under this contract was directed toward completion of a preliminary design and cost estimate for a 50 MW demonstration plant and a 200 MW plant design and cost estimate. Several process and design options are evaluated. Process flow diagrams, energy and material balances, equipment specifications, vessel drawings, equipment arrangement drawings, a site plan, an electrical oneline drawing, and utility requirements are presented for the recommended process concept. Plant performance, environmental impact, and functional operating conditions are presented and development requirements identified. Capital and operating costs are presented for the 50 MW demonstration plant and for commercial plants with capacities from 50 to 500 MW. Limestone sorbent support data is given. EPA CONTACT: Turner, P. P. 919-549-2825

650/2-75-027b PE 1AB013 ROAP/TASK 21 ADB 09 CONTRACT NO. 68-02-0605

Fluidized Bed Combustion Process Evaluation (Phase I – Residual Oil Gasification/Desulfurization Demonstration at Atmospheric Pressure) Volume II – Appendices Westinghouse Research Laboratories Pittsburgh, PA

This volume of the report summarizes results of an evaluation of the atmospheric-pressure fluidized bed residual oil gasification/ desulfurization process, a process referred to by its inventor (Esso Research Centre, Abingdon, England) as the chemically active fluidized bed (CAFB) process. The CAFB produces a clean, low heating value fuel gas for firing in a conventional boiler. The integrated process, previously operated successfully in a 750 kW pilot plant unit, has demonstrated the ability to meet environmental emission standards for sulfur oxides, nitrogen oxides, and particulates. Work carried out under this contract was directed toward completion of a preliminary design and cost estimate for a 50 MW demonstration plant and a 200 MW plant design and cost estimate. Several process and design options are evaluated. Process flow diagrams, energy and material balances, equipment specifications, vessel drawings, equipment arrangement drawings, a site plan, an electrical oneline drawing, and utility requirements are presented for the recommended process concept. Plant performance, environmental impact, and functional operating conditions are presented and development requirements identified. Capital and operating costs are presented for the 50 MW demonstration plant and for commercial plants with capacities from 50 to 500 MW. Limestone sorbent support data is given. EPA CONTACT: Turner, P. P. 919-549-2825

650/2-75-030 PE 1AB013 ROAP/TASK 21 ADE 10 CONTRACT NO. 68-02-1308

Sulfur Compound Emissions of the Petroleum Production Industry M. W. Kellogg Company Houston, TX

The report gives results of a study of sulfur compound emissions from the Permian Basin and the Smackover Formation, two areas that represent about 80% of the sulfur emissions from oil and gas fields in the U.S. SO_2 emissions from these two areas are estimated to be 664,000 short tons per year, of which 384,000 short tons per year are from Claus plant tail gases. H_2S emmissions are estimated to be 9000 short tons per year. The report lists the plants studied and tabulates the production of sulfur emissions by counties. EPA CONTACT: Samfield, M. 919-549-2815

NEW REPORT ABSTRACTS SECTION

650/2-75-031 PE 1AB013 ROAP/TASK 21 ACY 38 CONTRACT NO. 68-02-1013

Scale Control in Limestone Wet Scrubbing Systems Arthur D. Little, Inc. Cambridge, MA

The report gives results of tests of a number of phosphate and polymeric additives—which have proven effective in controlling scale in some commercially encountered calcium-containing systems—for scale control potential in limestone wet scrubbers. Additives selected were Lime Treet; Acrysol A-1, A-3, A-5, Calnox 214 DN; Darex 40; Dequest 2000; PD-8; sodium hexametaphosphate; Calgon CL-14; sodium pyrophosphate; Versenex 80; Quadrol; and sodium tripolyphosphate. Calnox 214 DN and Calgon CL-14 were found to be particularly effective in controlling sulfate scaling in the bench scale scrubber used for testing: both reduced the rate of scaling by 75% under conditions previously shown to lead to catastrophic sulfate scaling. The kinetics of oxidation of calcium sulfite in calcium carbonate/sulfite slurries was studied and compared with the oxidation of sodium sulfite solutions. Rates of oxidation in the calcium system, found to be proportional to bisulfite ion concentration, increased in the presence of solid calcium sulfite. Therefore the rate of sulfite dissolution is a contributing factor to the oxidation under normal operating conditions. Cationic impurities, such as sodium or magnesium, which can increase bisulfite concentration in solution in the 5–6 pH range, are expected to accelerate oxidation. EPA CONTACT: Borgwardt, R. H. 919–549–2234

650/2-75-032a PE 1AB013 ROAP/TASK 21 ADE 10 CONTRACT NO. 68-02-1329

Energy Consumption: The Chemical Industry Dow Chemical Company Freeport, TX

The report gives results of a study of energy consumption in the chemical industry. It analyzes energy-intensive steps or operations for manufacturing processes which produce 12 of the top 50 volume chemicals in the U.S. Results of the analyses are in the form of energy consumption block diagrams, energy-intensive equipment schematic diagrams, and tables that indicate the causes of energy losses, as well as possible conservation approaches. The most common energy-intensive operations in this industry are furnace operation, distillation, compression, refrigeration, electrolysis, drying/calcining, and evaporation. Energy losses in these operations could be reduced by: design, operation, market, and process modification; better insulation and maintenance; process integration; waste utilization; and research and development. EPA CONTACT: Jefcoat, I. A. 919–549–2745

650/2-75-032b PE 1AB013 ROAP/TASK 21 ADE 10 CONTRACT NO. 68-02-1329

Energy Consumption: The Primary Metals and Petroleum Industries Dow Chemical Company Freeport, TX

The report gives results of a study of energy consumption in the primary metals and petroleum industries. It analyzes energy-intensive steps or operations for commonly used manufacturing processes. Results of the analyses are in the form of energy consumption block diagrams, energy-intensive equipment schematic diagrams, and tables that indicate the causes of energy losses, as well as possible conservation approaches. The most common energy-intensive operations in these industries are: (primary metals) — furnace operation and electrolysis; and (petroleum) — furnace operation and distillation. Energy losses in these operations could be reduced by: design, operation, and process modification; better insulation and maintenance; process integration; waste utilization; and research and development. EPA CONTACT: Jefcoat, I. A. 919–549–2745

650/2-75-032c PE 1AB013 ROAP/TASK 21 ADE 10 CONTRACT NO. 68-02-1329

Energy Consumption: Paper, Stone/Clay/Glass/Concrete, and Food Industries Dow Chemical Company Freeport, TX

The report gives results of a study of energy consumption in the paper, stone/clay/glass/concrete, and food industries. It analyzes energy-intensive steps or operations for commonly used manufacturing processes. Results of the analyses are in the form of energy consumption block diagrams, energy-intensive equipment schematic diagrams, and tables that indicate the causes of energy losses, as well as possible conservation approaches. (The analysis of energy consumption in the food industry is not as quantitative as in the others.) The most common energy-intensive operations in these industries are: (paper) — pulp digestion (cooking), evaporation, furnace and kiln operations, and drying; (stone/clay/ glass/concrete) — kiln and furnace operations; and (food) — cooking, drying, and refrigeration. Energy losses in these operations could be reduced by: design, market, and process modification; better insulation and maintenance; waste utilization; process integration; and research and development. EPA CONTACT: Jefcoat, I. A. 919–549–2745

NEW REPORT ABSTRACTS SECTION

650/2–75–033 PE 1AB012 ROAP/TASK 21 ADL 04 CONTRACT NO. 68–02–1308

Particulate Collection Efficiency Measurements on a Wet Electrostatic Precipitator M. W. Kellogg Company Houston, TX

The report gives results of fractional and overall particulate collection efficiency measurements of a plate-type wet electrostatic precipitator (ESP) collecting fume from an aluminum pot line. Overall collection efficiencies, based on a mass train with an in-stack filter, ranged from 95.0 to 98.0%. The mass filter obtained much higher total outlet mass loadings than did the Andersen impactors, presumably because of large entrained liquor droplets which were captured by the mass traverse, but not by the single-point impactor measurements. The average minimum collection efficiency in the size range 0.2 to 1.0 micrometer diameter (based on the Andersen data) was 98.5%. Comparisons between measured (with Andersen impactors) and predicted collection efficiences obtained from a mathematical mode of an ESP indicated fair agreement in the size range 0.2 to about 1.3 micrometers. For larger particles, the collection-efficiency/particle-size relationship departed drastically from the expected pattern, possibly because of liquor carryover from the electrode irrigation system. EPA CONTACT: Sparks, L. E. 919–549–2557

650/2–75–034 PE 1AB013 ROAP/TASK 21 ADE 10 CONTRACT NO. 68–02–1323

Fuels Technology: A State-of-the-Art Review Battelle Columbus Laboratories Columbus, OH

The report gives results of a state-of-the-art review of various fuel-cleaning, fuel-conversion, and emission control technologies. It includes the following classes of technologies: physical and chemical coal cleaning, residual oil desulfurization, coal refining (liquefaction), coal and oil gasification, fluidized-bed combustion of coal, and stack gas cleaning. For each technology, the report presents the extent of current practice and the status of systems under development. EPA CONTACT: Chatlynne, C. J. 919–549–2915

650/2–75–035 PE 1AB014 ROAP/TASK 21 BCC 54 CONTRACT NO. 68–02–1436

Application of Automatic Data Processing Technology to Laboratory Problems Aerotherm Acurex Corporation Mountain View, CA

The report describes the design, acquisition, programming, and installation of a multiprogramming data acquisition system. Two multichannel experiments and a high-speed laser doppler velocimeter were interfaced. The laser velocimeter is interfaced by a bi-directional ASC II communication link. The mini-computer operating system supports several foreground data acquisition programs with concurrent background data processing. EPA CONTACT: Kuykendall, W. B. 919–549–2557

650/2–75–037 PE 1AB012 ROAP/TASK 21 ADJ 26 CONTRACT NO. 68–02–0265

Mathematical Model of Electrostatic Precipitation Southern Research Institute Birmingham, AL

The report describes a mathematical model which relates collection efficiency to electrostatic precipitator (ESP) size and operating parameters. It gives procedures for calculating particle charging rates, electric field as a function of position in wire-plate geometry, and the theoretically expected collection efficiencies for various particle sizes and ESP operating conditions. It proposes methods for empirically representing collection efficiency losses caused by non-uniform gas velocity distributions, gas bypassing the electrified regions, and particle reentrainment due to rapping of the collection electrodes. Incorporating these proposed techniques into a mathematical model of ESP performance reduces the theoretically calculated overall collection efficiencies. It compares the reduced efficiencies with those obtained from measurements on ESPs treating flue gas from coal-fired generating stations. It also presents the effects of changes in particle size distributions on calculated collection efficiences obtained from the mathematical model. EPA CONTACT: Sparks, L.

650/2–75–038 PE 1AB015 ROAP/TASK 21 AFH 25 CONTRACT NO. 68–02–1323

Potentially Hazardous Emissions From The Extraction and Processing of Coal and Oil BY G. Cavanaugh, C. E. Burklin, and J. C. Dickerson, Radian Corporation Austin, TX BY H. E. Lebowitz, S. S. Tam, G. R. Smithson Jr., H. Nack, and J. H. Oxley, Battelle Columbus Laboratories Columbus, OH

The report lists potentially hazardous materials which may be associated with the air, water, and solid waste from a refinery, a coke plant, a Lurgi high-Btu gas process, and the solvent refined coal process. Fugitive loss was identified as the major emissions source in the refinery, although its composition is difficult to quantify. Coking is the most offensive of the four processes assessed. Coal gasification may produce materials as dangerous as those from the coke plant, but the former will probably be more contained than coke oven emissions. The environmental impact of coal liquification is not well defined; however, liquefaction products will probably be more hazardous than crude oil products, and their refining and utilization will be worse offenders than corresponding petroleum operations. The study indicates that available documents are not adequate to develop an accurate list of potentially hazardous emissions from these four processes. A detailed assessment of the processes, field sampling, and analysis are needed to identify the potentially hazardous emissions more accurately. EPA CONTACT: Jefcoat, I. A.

NEW REPORT ABSTRACTS SECTION

650/2–75–042 PE 1AB015 ROAP/TASK 21 AFD 21 CONTRACT NO. 68–02–1314

Demonstration of Reduced Hydrocarbon Emissions from Gasoline Loading Terminals Amoco Oil Company Naperville, IL

The report gives results of test work to demonstrate the effectiveness of hydrocarbon oxidation for reducing emissions from a gasoline truck loading terminal in Philadelphia that pumps about 2 million barrels of gasoline per year. Major objectives of the program were to determine control efficiency, to observe operational characteristics, and to compare this installation with other known systems. Tests run during each of the four seasons showed that the oxidizer safely and efficiently disposes of 99 + % of the vapor it receives, even in extremely cold weather when the air-gasoline vapor mixture is in the flammable range. Initially, a large portion of the vapor from the trucks was not reaching the oxidizer, primarily because of blockage caused by liquid carryover to the vapor collection system. After this was corrected, collection and disposal of the vapor exceeded 90%. High efficiency and low flame temperatures of the oxidizer limit formation of emissions. EPA CONTACT: Rhodes, W. J. 919–549–2851

650/2–75–044 PE 1AB013 ROAP/TASK 21 AQQ 10 CONTRACT NO. 68–02–1324

St. Louis Refuse Processing Plant Equipment, Facility, and Environmental Evaluations Midwest Research Institute Kansas City, MO

The report describes partial results of the following tests and evaluations at the St. Louis refuse processing plant from 9/74 to 1/75: plant mass and energy balances; equipment and plant performance evaluations; an analysis of plant operating costs; particulate emission tests on the hammermill and air classification system dust collection cyclones; a pollution evaluation of plant washdown water; and a plant sound survey. The plant operated satisfactorily during the evaluation period, with about 80% of the incoming refuse converted to refuse fuel, on both a mass and energy basis. No major equipment breakdowns occurred. Plant operating and maintenance costs ranged from $2.58 to $14.80/ton of refuse produced, with costs varying primarily as a function of tonnage. Particulate emissions from the hammermill cyclone discharge were less than 0.01 gr/dscf; those from the air classifier cyclone discharge averaged 0.209 gr/dscf (about 1.25 lb/ton of refuse processed). Over 80% by weight of these particles had mean diameters greater than 10 micrometers. Washdown water samples showed significant increases in TSS, BOD, and COD; however, the small quantity of effluent (2000 gal., twice/week) can be handled easily by the average municipal waste treatment facility. At 8 of the 17 plant positions at which sound measurements were taken, sound levels were in excess of 90 dBA, the maximum OSHA level for continuous 8-hour exposure. EPA CONTACT: Kilgroe, J. D.

650/2–75–045 PE 1AB013 ROAP/TASK 21 ACX 82 CONTRACT NO. 68–02–0297

Stone & Webster/Ionics SO_2 Removal and Recovery Process: Phase I, Final Report Wisconsin Electric Power Company Milwaukee, WI

The report covers Phase I of a potential three-phase program to evaluate the Stone & Webster/Ionics process at I MW pilot plant scale with the option to scale up and demonstrate process viability at the 75 MW prototype level. The report cites the objectives, approach, results, and conclusions, and discusses a program that included: the design, construction, and operation of, and completion of a test program for, the pilot plant; the design, construction, and testing of prototypesize electrolytic regeneration cells; the design, engineering, and estimation of construction and operating costs of the 75 MW prototype; and preparation of a test program and operating schedule for the prototype. An executive summary includes the background and objectives of the overall program and pilot-scale effort, and highlights significant results and conclusions. Although technical feasibility was demonstrated at the pilot scale, the economics of a 75 MW prototype plant at the site of the pilot plant do not appear favorable. There are no current plans to continue into Phase II (detailed design, procurement, and installation of the 75 MW prototype) or Phase III (12-month start-up and operational test period for the 75 MW prototype). EPA CONTACT: Maxwell, M. A. 919–549–2915

650/2–75–046 PE 1AB013 ROAP/TASK 21 BBZ 08 CONTRACT NO. 68–02–1320

Evaluation of Low-Sulfur Western Coal Characteristics, Utilization, and Combustion Experience Monsanto Research Corporation Dayton, OH

The report summarizes the data on western coal statistics, combustion, and mining. Detailed information is presented for coal occurrence, production, composition, and physical and chemical properties. Discussions and economic analyses are given of available mining techniques and transportation modes to bring these vast coal reserves to large fuel combustion markets. The effects of western coal properties on combustion equipment operation and emissions to the atmosphere are evaluated. The overall impact of increased western coal production on the environment is also analyzed and recommendations are made for further investigation of problematic areas. EPA CONTACT: Lachapelle, D. G.

NEW REPORT ABSTRACTS SECTION

650/2-75-047 PE 1AB013 ROAP/TASK 21 ACY 32 CONTRACT NO. PH 22-68-6

EPA Alkali Scrubbing Test Facility: Summary of Testing Through October 1974 Bechtel Corporation San Francisco, CA

The report describes test results through 10/74 from a lime/limestone scrubbing test facility for removing SO_2 and particulates from flue gases. The facility consists of three parallel scrubbers—a venturi/spray tower, a Turbulent Contact Absorber (TCA), and a marble-bed absorber— each able to treat a 10 Mw equivalent (30,000 acfm) of flue gas from a coal-fired boiler at TVA's Shawnee Station. Limestone factorial tests were conducted on all three scrubbers to determine the effects of the independent variables on SO_2 and particulate removal. Limestone reliability verification tests were conducted on all three scrubbers to define regions for scale-free operation. Lime and limestone reliability tests were conducted on the venturi/spray tower and TCA systems, respectively, to demonstrate long-term reliability, primarily of the mist elimination systems. The TCA mist elimination system (a Koch Flexitray in series with a chevron mist eliminator) has remained essentially clean over a 1000 hour period at a superficial gas velocity of 8.6 ft/sec. A recent test of the spray tower mist elimination system (a chevron mist eliminator with provision for underside and topside washing) at a superficial gas velocity of 6.7 ft/sec indicated that long-term operability of this system may be expected. EPA CONTACT: Williams, J. E. 919-549-2915

650/2-75-057a PE 1AB013 ROAP/TASK 21 ACX 130 CONTRACT NO. 68-02-1321

Survey of Flue Gas Desulfurization Systems Cholla Power Generating Station, Arizona Public Service Company PEDCo-Environmental Specialists, Inc. Cincinnati, OH

The report gives results of a survey of a wet limestone system for desulfurization of flue gas on Unit I of the Cholla Power Generating Station of Arizona Public Service Company (APSCo). This base-load unit has a maximum continuous net generating capacity of 115 MW. At capacity, the boiler burns 54 tons of pulverized coal per hour. The typical gross heat content of the coal, as received, is 10,290 Btu per pound; typical ash and sulfur contents are 10.4 and 0.55 percent, respectively. The system consists of two parallel scrubbing train modules, each accommodating 50 percent of the flue gas. Both modules include an adjustable flooded-disc scrubber for particulate control, followed by a tower. The module A tower is packed, utilizing a limestone slurry for SO_2 removal. The module B tower contains no packing, and limestone is not circulated through it. APSCo estimates module B SO_2 removal efficiency to be 25 percent. The system operates in an open-loop mode, since there is no recycling of liquor from the fly ash pond. Approximately 386 gallons of make-up water are required per pound-mole of SO_2 removed. Installed cost for the system is reported to be about $6.5 million, or $57 per KW. Annualized costs are estimated to be 2.2 mills/KWHr, including a 23 percent charge on capital investment to account for interest, depreciation, taxes, and other fixed charges. EPA CONTACT: Ponder, W. H. 919-549-2915

660/2-75-012 PE 1BB039 ROAP/TASK 21 ARS 02 GRANT NO. 802205

Survival of Pathogens in Animal Manure Disposal BY S. L. Diesch, P. R. Goodrich, B. S. Pomeroy, and L. A. Will, Minnesota, University of St. Paul, MN

A research project was conducted to measure and evaluate the public health effects of pathogens in beef cattle manure found in the extended aeration system of waste disposal. Model oxidation ditches were used in laboratory studies. At simulated summer and winter environmental conditions determinations were made of the viability and infectivity of leptospires in weanling hamsters and salmonella in turkey poults. Salmonella was transmitted by aerosols, but leptospires were not. In refeeding contaminated slurry contents salmonella was transmitted but leptospires not. Leptospires isolated from the slurry of the model ditch 17 days post seeding had lost measurable virulence. Measurements of selected microbial aerosols were made in the vicinity of a field ditch. Bacterial levels of 100-200 total colony-forming units per liter of air were associated with the beef cattle population in the housing unit and not with aerosols generated by the oxidation ditch treatment system. Studies were made on a model oxidation ditch simulating the field ditch. The winter temperature conditions (2 degrees – 5 degrees C) slowed the degradation process considerably and high dissolved oxygen was maintained. EPA CONTACT: Yin, S. C.

660/2-75-014 PE 1BB036 ROAP/TASK 21 AZT 06 GRANT NO. 800294

Recycle of Synthetic Warp Sizes From Textile Desizing Wastewater BY C. E. Bryan, North Carolina State University Raleigh, NC

In an earlier project for the Environmental Protection Agency, a process was developed on a small scale for precipitating carboxymethyl cellulose (CMC) from desizing wastewater with filter alum and recovering and dissolving the precipitate to give a solution suitable for reuse in sizing warp yarns. More extensive recovery trials have now been made on plant desizing wastewater to give sufficient material for weaving trials and for developing a practical procedure for size recovery. Weaving trials using warp yarns sized with CMC recovered from plant desizing wastewater were as satisfactory as those using warps sized with new CMC. Desizing and dyeing the woven fabrics showed no difference in hand and shade that could be attributed to the recovered CMC. The yarns were blends of polyester and cotton (65:35) and polyester and rayon (65:35). Sufficient dewatering of the precipitated CMC – to ten percent solids or higher was accomplished by centrifuging or by the use of a Dual Cell Gravity (DCG) unit (Permutit Co.) alone or, preferably, in combination with a Multi-Roll Press (MRP) unit (Permutit Co.). EPA CONTACT: Sargent, T. N.

NEW REPORT ABSTRACTS SECTION

660/2–75–015 PE 1BB039 ROAP/TASK 21 BEQ 12 IAG NO. IAG D4–0446

Pollution Abatement From Cattle Feedlots in Northeastern Colorado and Nebraska BY L. K. Porter, F. G. Viets, T. M. McCalla, L. F. Elliott, F. A. Norstadt, H. R. Duke, N. P. Swanson, L. N. Mielke, and G. L. Hutchinson, U.S. Department of Agriculture Fort Collins, CO

Climatic factors, feedlot runoff, and organic material in the runoff were evaluated in experimental and commercial feedlots. The effects of slope, stocking rates, terraces, basins, and holding ponds were evaluated to obtain the best controls for containing runoff. In eastern Nebraska, 70 cm annual precipitation produces 23 cm of runoff; whereas, in northeastern Colorado, 37 cm annual precipitation gives only 5.5 cm of runoff. Large applications of runoff liquid, up to 91 cm on grass-Ladino and 76 cm on corn, in Nebraska did not decrease yields; however, in northeastern Colorado, the concentrated high-salt runoff required dilution before direct application to crops. The organic manure-soil interface severely restricts the movement of water, nitrates, organic substances, and air into the soil beneath feedlots. The amounts of NO_3-N in soil cores taken from Nebraska feedlots and croplands ranked as follows: abandoned feedlots, feedlot cropland, upland feedlots, river valley feedlots, manure mounds, alfalfa, grassland. Feedlots contribute NH_3, amines, carbonyl sulfide, H_2S, and other unidentified substances to the atmosphere. Ammonia and amine can be scavenged from the air by green plants and water bodies. Anaerobic conditions in feedlots are conducive to the production of carbonyl sulfide, H_2S, and amines. Management practices, such as good drainage, that enhance aeration will decrease the evolution of these compounds. EPA CONTACT: Shuyler, L. R.

660/2–75–017 PE 1BB036 ROAP/TASK 21 AZR 09 GRANT NO. 800312

Radiation Treatment of High Strength Chlorinated Hydrocarbon Wastes BY T. F. Craft, R. D. Kimbrough, and C. T. Brown, Georgia Institute of Technology Atlanta, GA

The possible use of gamma radiation for the treatment of waste effluents containing chlorinated hydrocarbons, particularly pesticides, has been investigated. Significant destruction was obtained of representative compounds such as pentachlorophenol, 2,4,5-trichlorophenoxyacetic acid, and 2, 4-dichlorophenoxacetic acid. Radiation treatment had little effect on polychlorinated biphenyls or mixtures of compounds, including actual manufacturing effluents. It was found that the addition of a material of high atomic weight, such as barium, increased the efficiency of radiation utilization. No other materials were found which increased the desired destruction. G-values were calculated for pentachlorophenol, 2,4,5-trichlorophenoxyacetic acid, and 2,4-dichlorophenoxyacetic acid. It is concluded from the magnitude of these values that radiation treatment of chlorinated hydrocarbons is not economically feasible at the present level of radiation costs. EPA CONTACT: Swank Jr., R. R.

660/2–75–018 PE 1BB045 ROAP/TASK 21 ASH 18 IAG NO. IAG D4–F451

Use of Climatic Data in Design of Soils Treatment Systems BY D. Whiting, U.S. Department of Commerce Asheville, NC

Planners, designers and operators of land-based wastewater management systems need information about climatic influences on the determination of storage requirements. Parameters of special interest are discussed and two guidelines have been developed. The guideline referred to as the freezing index is recommended for stations whose average normal temperature during the coldest month is less than 32 degrees F, while a study of days defined as either favorable or unfavorable is recommended for stations in the warmer climatic zones. The effect of a run of unfavorable days immediately following a cold period can also be determined by examining the daily listings. A number of graphs, charts and maps are included to describe ways of presenting climatological data and to show the availability of summarized climatic elements. Air temperature, ground frost, evaporation, precipitation, snowfall, snow depth and wind direction and speed are discussed in relation to the possible affect of each on land application systems. EPA CONTACT: Thomas, R. E.

660/2–75–019 PE 1BB037 ROAP/TASK 21 BAA 23 GRANT NO. 802174

Egg Breaking and Processing Waste Control and Treatment BY W. J. Jewell, H. R. Davis, O. F. Johndrew Jr., R. C. Loehr, W. Siderewicz, and R. R. Zall, Cornell University Ithaca, NY

Eleven percent of the eggs produced in the U.S. are handled by egg breaking facilities to produce more than 800 million pounds of various egg products annually. Five egg breaking plants were sampled which covered a size ranging from small installations to one of the largest. The wastewater was highly contaminated, with total COD exceeding 6000 mg/1 or greater. The product loss average was 12.5 percent of the weight of the processed product. Unit process losses were 0.034 kg BOD_5 and 7.5 liters per kg of egg liquid produced. In-plant waste conservation methods were demonstrated to decrease BOD_5 and wastewater volume losses by 50 and 24 percent, respectively. These reductions in product loss resulted in recovery of product with a value between $250 and $500 per day for a medium sized facility. Treatment of the wastewater by the activated sludge process and by aerated lagoons did not decrease the effluent pollutant concentrations to levels acceptable for direct discharge. Aerobic lagoons with 30 day HRT reduced the total COD from 5800 mg/1 to 1000 mg/1. Of the four treatment systems tested, only a combination of an anaerobic lagoon followed in series with an aerated lagoon and a liquid solids separation step produced a dischargeable effluent with soluble BOD_5 less than 15 mg/1. EPA CONTACT: Witherow, J.

NEW REPORT ABSTRACTS SECTION

660/2-75-020 PE 1BB036 ROAP/TASK 21 AZP 27 GRANT NO. 12050 GTR

Refinery Effluent Water Treatment Plant Using Activated Carbon BY G. C. Loop, Atlantic Richfield Company Carson, CA

Reduction of Chemical Oxygen Demand (COD) in petroleum refinery effluent wastewater by adsorption onto activated carbon was demonstrated on a commercial level during a two-year project at Carson, California. The plant contained over 750,000 pounds of carbon, regenerated 1,644,000 pounds of carbon, processed 172 million gallons of water, and removed 408,000 pounds of COD. The carbon was exhausted at the rate of 9.5 pounds per 1000 gallons of water processed. At an average feed COD concentration of 250 ppm and an average effluent COD concentration of 50 ppm, the carbon was loaded to an average of 0.26 pounds of COD per pound of carbon. Following solution of initial startup problems, the unit was operated at a cost of 40 cents per 1000 gallons of water treated, or 18 cents per pound of COD removed. EPA CONTACT: Myers, L.

660/2-75-021 PE 1BB036 ROAP/TASK 21 AZP 36 GRANT NO. 800766

Optimizing a Petrochemical Waste Bio-Oxidation System Through Automation BY M. A. Zeitoun, W. F. McIlheny, N. J. Riscan, J. H. Culp, and H. C. Behrens, Dow Chemical Company Freeport, TX

Systems were developed to control the critical parameters of the activated sludge process to achieve reliable, high quality effluent. An automated sampling system, sampling feed and homogenized mixed liquor, monitored the total carbon in both samples. Nutrients were added in proportion to the total carbon in the feed, thus maintaining low residual nutrients in the effluent. The sludge recycle flow rate was controlled by a food to microorganisms signal, measured as the ratio of total carbon in the feed to that in the mixed liquor. Toxic or inhibitory effects of the feed were measured by a Biological Inhibitor Detector, an instrument which measures the oxygen uptake of standard solutions before and after exposure of a bacteria sample to a feed sample and calculates an activity ratio. The use of the instrument as an upstream sensing device was demonstrated as toxic substances were added to the feed. The developed on-line control systems are applicable to municipal, industrial or combined treatment plants. A bibliography of 63 references is included. EPA CONTACT: Short, T. E.

660/2-75-022 PE 1BB045 ROAP/TASK 21 AS[illegible] 13 IN-HOUSE PROJECT

Kinetic Model for Orthophosphate Reactions in Mineral Soils BY C. G. Enfield, and B. E. Bledsoe, Robert S. Kerr Environmental Research Laboratory, EPA Ada, OK

The ability of a soil to remove wastewater phosphorus from solutions passing through the soil matrix is primarily related to the formation of relatively insoluble phosphate compounds of iron, aluminum, and calcium. Based on the solubility of these compounds, an estimate can be made of the minimum concentration of phosphorus which will be found at equilibrium in the soil solution. The kinetics of orthophosphorus sorption with 25 viable mineral soils were experimentally measured under laboratory conditions. Several kinetic models were evaluated as a means of describing phosphorus sorption by soil. A diffusion limited Langmuir sorption model best fit the experimental data. EPA CONTACT: Harlin Jr., C. C.

660/2-75-024 PE 1BB037 ROAP/TASK 21 AZX 55 IN-HOUSE PROJECT

Taxonomy of Klebsiella pneumoniae Isolated From Pulp/Paper Mill Wastewater BY M. D. Knittel, Pacific Northwest Environmental Research Laboratory, EPA Corvallis, OR

K. pneumoniae isolated from pulp mills was compared to clinical isolates of *K. pneumoniae*. Cultures found to be identical in biochemical reaction in various media and conformed to the recognized schemes of classification of *K. pneumoniae*. Nucleic acid base composition comparison of these isolates showed that all exhibited a G+C% base composition of 56% +1.4%, and all cultures examined fell within this range. A study of the heterologous binding capability between NDAs of these cultures revealed that isolates from both the environment and pathogenic reference had a base sequence from 80 to 100% in common. This confirms the earlier results that pulp mill isolates are the same as clinical isolates. EPA CONTACT: Knittel, M. D.

NEW REPORT ABSTRACTS SECTION

660/2-75-025 PE 1BB036 ROAP/TASK 21 AZP 28 GRANT NO. 803026

Chemical Coagulation/Mixed Media Filtration of Aerated Lagoon BY J. F. Grutsch, R. C. Mallatt, and A. W. Peters, American Oil Company Yorktown, VA

Operating problems and the effect of operating variables were investigated during full-scale plant operations in the scalping mode. Influent suspended solids concentration and water temperature were the most significant independent variables. Mechanical limitations were studied, including a filter bed disturbance that necessitated a total bed replacement. High, localized backwash velocity caused the invisible disturbance which reduced turbidity removal from about 80 percent to 50 percent. Diagnostic procedures, design changes, and the costs of operation and maintenance are reported. A cold weather study showed that a three-chemical destablization pretreatment system is required for filtration of biocolloids in brackish water. Determination of the optimal three-chemical destabilization system using zeta potentials required evaluation of zeta potentials in a manner which sorted out the effect of double-layer repression. The colloid destabilization mechanisms of charge neutralization and bridging were required for optimal filter performance. For colder water temperatures, even with optimal chemical treatment, the filter hydraulic loading must be decreased. The change in hydraulic loading with temperature related directly to the water's viscosity. EPA CONTACT: Myers, L. H.

660/2-75-026 PE 1BB045 ROAP/TASK 21 ASH 17 GRANT NO. 802168

Water Quality Control Through a Single Crop Agriculture, No. 4 BY K. R. Lundberg, and P. T. Trihey, Bemidji State College Bemidji, MN

A study was conducted to determine effects on water quality from flooded paddies used for the commercial culture of wild rice, *Zizania aquatica.* Water samples were taken from flooded impoundments on fertilized peat and mineral soils as well as unfertilized peat soils. Weekly changes in the chemical and physical parameters of water entering, within, and discharged from paddies were measured through the summer. No significant changes were observed in the receiving waters until fall draindown occurred when increases in dissolved solids, total Kjeldahl-nitrogen and total phosphorus occurred in the Clearwater River. Algal assay tests indicated that the increase in nutrients at peak discharge was sufficient to increase algal populations. The quantities of nutrients released from rice paddies were not significantly greater than would be expected in normal runoff in the area and much less than the amounts released from most agricultural endeavors. Consumptive water use was found to be 20–22 inches per acre (51–56 cm/ha). EPA CONTACT: Thomas, R.

660/2-75-027 PE 1BB392 GRANT NO. 801867

Turbulent Bed Cooling Tower BY R. G. Barile, Purdue University West Lafayette, IN

The purpose of this work is to determine whether the turbulent bed contactor (TBC), a relatively new and efficient device commonly used for gas scrubbing, can be proven as a competitive cooling system in electric power generation. The turbulent bed employs light, hollow plastic sphere as a packing which fluidize as air flows upward through the bed, while water is sprayed downward over the bed. It was desired to demonstrate the feasibility, collect sufficient data to permit scaleup design, and estimate the investment and costs involved. Pressure drop and cooling performance of the bed were measured for the airwater system in a vertical column, 0.29 m. I.D. and 2.44 m. high, under conditions typical of industrial cooling tower applications. It was found that the TBC performed marginally as compared with conventional mechanical draft cooling towers, requiring as much as twice the auxillary power per unit cooling load while the capital investment is likely to be less due to the smaller height of the TBC. EPA CONTACT: Shirazi, M. A.

660/2-75-028 PE 1BB037 ROAP/TASK 21 AZX 18 GRANT NO. 802084

Organic Compounds in Pulp Mill Lagoon Discharge BY B. F. Hrutfiord, T. S. Friberg, D. F. Wilson, and J. R. Wilson, Washington, University of Seattle, WA

Organic compounds entering and leaving kraft mills aerated lagoons have been identified and determined quantitatively. The compounds found were terpenes and related low B.P. materials, resin and fatty acids, phenols and sugar acids. The terpenes, resin and fatty acids are similar to those present in the wood specie being pulped. Some terpenes, phenols and sugar acids are produced during the pulping reactions. About 8 ppm total terpenes were found in the lagoon influent and 1 ppm or less were in the effluent. a-Terpineol was the major compound entering the lagoon and camphor the main terpene in the effluent. The total resin acid concentration entering the lagoon was 3.2 ppm with 0.6 ppm leaving. Fatty acids were lower both entering and leaving the lagoon. Sugar acids were found at about 100 ppm total entering, these were usually completely eliminated in the lagoon. Control of terpenes can be done by in-process steam stripping and the other compounds can be partially controlled by in-plant spill containment. EPA CONTACT: Keith, L.

NEW REPORT ABSTRACTS SECTION

660/3–75–021 PE 1BA026 ROAP/TASK 21 AKT 35 GRANT NO. 800536

Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations BY D. C. McNaught, M. Buzzard, and S. Levine, New York, State University of Albany, NY

The Crustacean zooplankton are excellent indicators of environmental perturbation, especially if enough of their biology is known to explain why certain species increase with nutrient enrichment of lakes. The distribution of zooplankton in Lake Ontario suggested that eutrophic indicators were found in the vicinity of major urban centers. The ratio of the number of *Bosmina longirostris*, the most successful eutrophic species, to *Disptomus sicilis*, the most oligotrophic form, supported this conclusion. Furthermore, mathematical indices, including diversity, the community competition coefficient, and carrying capacity, separated urban inshore from rural inshore waters, further evidence of perturbation. Biomass estimates made with new acoustical techniques indicated that most of the zooplankton biomass was in deep waters, thus the eutrophication of Ontario's waters, both nearshore and in the vicinity of cities, is still localized in nature. Mathematical techniques have been developed to model such perturbations. EPA CONTACT: Thomas, N. A.

660/3–75–025 PE 1BA025 ROAP/TASK 21 AIT 01 GRANT NO. 16070 DGO

Tidal Flats in Estuarine Water Quality Analysis BY D. A. Bella, Oregon State University Corvallis, OR

The initial phases of the study involved mixing processes and tidal hydraulics; however, the study emphasis shifted to estuarine benthic systems as the importance of these systems became more apparent. A conceptual model of estuarine benthic systems was developed and a classification system of estuarine benthic deposits which is based on the availability of hydrogen acceptors and reactive iron was developed. Field studies demonstrated that estuarine sediments and overlying wastes could contain significant concentrations of free sulfides which are toxic to a variety of organisms. Field studies of benthic oxygen uptake and benthic sulfide release were conducted. Water quality profiles within the deposits also were determined. A number of laboratory studies were conducted to determine the rate of sulfate reduction. Results from experiments using extracts from benthic deposits and algal mats demonstrated a close relationship between the rate of sulfate reduction and the sulfate and soluble organic carbon concentrations. A general systems model of estuarine benthic systems was developed. A variety of activities which could contribute to significant environmental changes with estuarine benthic systems were identified. Methods of determining dispersion coefficients from salinity profiles were examined and an improved method was developed. The build-up of a pollutant in the vicinity of the outfall during the slack water period of tide was studied through a field experiment and mathematical model study. EPA CONTACT: Callaway, R.

660/3–75–026 PE 1BA022 ROAP/TASK 21 ARY GRANT NO. 801124–03

Environmental Studies of an Arctic Estuarine System BY V. Alexander, D. C. Burrell, J. Chang, R. T. Cooney, C. Coulon, J. J. Crane, J. A. Dygas, G. E. Hall, and P. J. Kinney, Alaska, University of Fairbanks, AK

The Colville River estuarine system was studied over a period of four years. Physical, chemical, geomorphological and biological features was included. North slope river deltas differ significantly from those elsewhere, due to climatological extremes and a long, cold, dark winter with continuous ice-cover and continuous daylight during the summer with melting ice or open water. Basic information has been obtained on the winds, waves and currents. Predominant current directions are from the west, with wind drift currents with a periodicity of 4 to 5 days. Beach sediments are characterized as poorly sorted gravelly sandy sediment in a relatively low energy environment. The ice-free biological regime is strongly influenced by the river input of low salinity water containing relatively high concentrations of nitrogen nutrients. An annual primary production in the estuary is estimated at 10-15 g-C/m2. Crustaceans, molluscs and polychaetes characterize the macrofauna at depths exceeding 2 m, with but few species responsible for most of the biomass. Interesting features of the chemical regime are connected with the isolation of hypersaline water in the shallow estuarine and river system. Fresh water systems were included in the study. EPA CONTACT: Schallock, E. W.

660/3–75–027 PE 1BA031 ROAP/TASK 21 AJF 05 GRANT NO. 800504

Nutritional Ecology of Nuisance Aquatic Plants BY G. C. Gerloff, Wisconsin, University of Madison, WI

Plant analysis was compared with other techniques in assays for available and growth-limiting nutrients in northern Wisconsin lakes. The data were in poor agreement. To further develop plant analysis, critical concentrations of a number of elements were established in various macrophytes and algae. Critical concentrations varied markedly in different organisms. The plant analysis bioassay indicated K supply, rather than N or P, became limiting for macrophyte growth in a eutrophic lake. Three procedures were developed to evaluate the capacities of macrophytes and algae to compete for nutrients at the low concentrations in lakes. These procedures involved (1) competition between several organisms in the same culture for a growth-limiting amount of a nutrient, (2) nutrient replacement in cultures to establish the borderline concentration at which an organism failed to make maximum growth even though the total nutrient supply was adequate, and (3) measurement of rates of nutrient uptake and calculation of Vmax and Km values. The competitive and uptake capacities of various aquatic plants for a specific element differed markedly. EPA CONTACT: Miller, W. E.

NEW REPORT ABSTRACTS SECTION

660/3-75-030 PE 1BA024 ROAP/TASK 21 AKQ 14 GRANT NO. 801381

Nitrogen in the Subsurface Environment BY M. L. Rowe, and S. Stinnett, Oklahoma State University Ada, OK

Increased quantities of various forms of nitrogen being released to the soil systems and higher concentrations of nitrogeneous compounds are consequently making their way into subsoil regions. Knowledge of the behavior and fate of nitrogeneous chemical species in the subsurface environment is needed by those concerned with the prevention and control of groundwater pollution. This paper presents information concerning the nature and origin of nitrogeneous substances polluting ground water, the probable movement and reaction of nitrogeneous compounds in the subsurface environment, and specific cases of ground-water pollution by nitrogen-containing compounds. EPA CONTACT: Scalf, M. R.

660/3-75-032 PE 1AA006 ROAP/TASK 21 ALU 32 IN-HOUSE PROJECT

Chemical/Biological Relationships Relevant to Ecological Effects of Acid Rainfall BY J. O. Reuss, National Ecological Research Laboratory, EPA Corvallis, OR

This paper deals with problems of measurement and interpretation of rainfall acidity in terms of effects on the soil-plant system. The theory of the carbon dioxide-bicarbonate equilibria and its effect on rainfall acidity is given. The relationship of a cation-anion balance model of acidity in rainfall to plant nutrient uptake processes is discussed, along with its relationship to a model previously proposed in the literature. Average H+ concentration calculated from pH measurements does not appear to be a satisfactory method of determining H+ loading from rainfall if the rain is not consistently acid. Calculating loading from H+ minus HCO_3, strong acid anions minus basic cations, or net titratable acidity is suggested. The flux of H+ ions due to plant uptake processes and sulfur and nitrogen cycling is considered. H+ is produced by oxidation of reduced sulfur and nitrogen compounds mineralized during decomposition of organic matter. Plant uptake processes may result in production of either H+ or OH- ions. Fluxes of H+ from these processes may result in production of either H+ or OH ions. Fluxes of H+ from these processes are much greater than rainfall H+ inputs, complicating measurement and interpretation of rainfall effects. The soil acidifying potential due to the oxidation of the NH_4 in rainfall is apparently of a similar magnitude to the direct acidity inputs. EPA CONTACT: Reuss, J. O.

660/3-75-033 PE 1BA031 ROAP/TASK 21 AIY 16 GRANT NO. 801363

Lake Classification — A Trophic Characterization of Wisconsin Lakes BY P. D. Uttormark, and J. P. Wall, Wisconsin, University of Madison, WI

The design and application of the Lake Condition Index (LCI) system of classifying lakes is described, and it is demonstrated that lake classification can be employed as a useful tool by resource managers for comparing the trophic condition of large numbers of lakes. The LCI system was generated when an evaluation of other systems revealed that most are presently unsuitable for classifying the vast majority of lakes because the analytical data required for their use are lacking. Utilizing subjective information, the LCI system was applied to the classification of more than 1100 large Wisconsin lakes. Checks of the results show that 86% of the lakes were appropriately classified within the limits of the system; 14% were misclassified, as judged by individuals familiar with the lakes in question. Most, but not all, discrepancies were due to erroneous input data. The LCI values obtained were coupled with nutrient-loading considerations and shoreline density-development factors to demonstrate that lake classification can serve as a workable data base for lake renewal and management programs. The LCI system is easily modified to incorporate additional data for special purposes. The system could be used to classify an estimated 70–80% of the larger lakes in the United States. EPA CONTACT: Malueg, K.

660/3-75-034 PE 1BA031 IN-HOUSE PROJECT

Proceedings: Biostimulation-Nutrient Assessment Workshop Pacific Northwest Environmental Research Laboratory, EPA Corvallis, OR

The workshop was held to bring together those investigators in the Environmental Protection Agency who are actively engaged in research relating to biostimulation and nutrient assessment to present the results of their studies. The papers presented were concerned with the results of algal assays conducted on various waters and wastes to determine their biostimulatory effects as well as the results of other research relating to the assessment of nutrients and their effects on the aquatic ecosystem. EPA CONTACT: Maloney, T.

NEW REPORT ABSTRACTS SECTION

660/3–75–035 PE 1EA077 ROAP/TASK 10 AKC 06 IN-HOUSE PROJECT

Microbial-Malathion Interaction in Artificial Salt-Marsh Ecosystems: Effects and Degradation BY A. W. Bourquin, Gulf Breeze Environmental Research Laboratory, EPA Gulf Breeze, FL

Malathion is rapidly degraded *in vitro* by salt-marsh bacteria to malathionmono-carboxylic acid, malathion-dicarboxylic acid and various phosphothionates as a result of carboxyesterase cleavage. In addition, some expected phosphatase activity produces desmethyl-malathion, phosphotionates, 4-carbon dicarboxylic acids, and corresponding ethyl esters. In a simulated salt-marsh environment, malathion is degraded by the indigenous bacterial community. Numbers of bacterial capable of degrading malathion in the presence of additional nutrients increase in the sediments with increasing frequency of application and in the water column with the increasing level of treatment. Numbers of bacteria which degrade malathion as a sole carbon source are linked to the level of treatment in sediments and the frequency of treatment in the water column; however, these bacteria do not appear to play a significant role in the dissipation of malathion. I believe that frequency of treatment, increases numbers of malathion co-metabolizing bacteria which catalyze a more rapid dissipation of the compound, which results in fewer sole carbon degraders. The disappearance of malathion in the salt-marsh environment is influenced by both chemical and biological degradation; however, at temperatures below 26 C and salinities below 20 %, chemical mechanisms appear to be of less importance than biological degradation. EPA CONTACT: Bourquin, A. W.

660/3–75–036 PE 1AA006 ROAP/TASK 21 ALU 03 IN-HOUSE PROJECT

Some Effects of Cadmium on Coniferous Forest Soil/Litter Microcosms BY H. Bond, B. Lighthart, R. Shimabuku, and L. Russell, National Environmental Research Laboratory, EPA Corvallis, OR

Description and criticism is given of a preliminary design and use of a soil/litter microcosm in which oxygen, temperature and humidity are kept constant and oxygen generation and carbon dioxide and heat evolution rates are monitored. Using four microcosms, one acting as a dead control, experiments were performed giving the following results: for "identically" prepared and incubated microcosms, the coefficient of variation was as small as 3.8 percent for carbon dioxide evolution rate and as large as 9.9 percent for oxygen consumption rates. It was also found that an adjustment period of seven to ten days after microcosm preparation was necessary to approach relatively constant production rates. For microcosms adjusted to 10, 30, and 60 percent of field water holding capacity, oxygen and carbon dioxide rates, and bacterial densities vary directly whereas the fungi and actinomycetes varied inversely; while for cadmium amended microcosms, 0.01 ppm and initial stages in the 10 ppm $CdCl_2$ unit, oxygen consumption was stimulated suggesting respiratory enzyme uncoupling while in the later stages the 10 ppm cadmium amended soils reduced both O_2 and CO_2 respiration by 40 percent. No organismal density changes due to cadmium were detected indicating the cadmium initially affects respiration, possibly by uncoupling respiratory phosphorylation, and that longer experiments might be necessary to detect population density changes. EPA CONTACT: Lighthart, B.

660/3–75–037 PE 1BA032 ROAP/TASK 21 AJH 35 CONTRACT NO. 68–03–0439

Improving the Statistical Reliability of Stream Heat Assimilation Prediction BY R. W. McLay, M. S. Hundal, and K. R. Lamborn, Richard McLay, Consulting Engineers Essex Junction, VT

This work is an evaluation of existing, one-dimensional stream temperature prediction techniques for accuracy and precision. A sensitivity analysis of a general model is used in conjunction with statistical methods to determine solution errors. Data taken in 1973 at the Vernon, Vermont nuclear plant are used as a data base. These data are used with Burlington, Vermont airport weather station data to 1) gain insight into the orders-of-magnitude of the various errors and 2) carry out a detailed data analysis to establish probabilities of meeting given error requirements. EPA CONTACT: Tichenor, B.

660/3–75–038 PE 1BA032 ROAP/TASK 21 AJH 12 GRANT NO. 800613

Evaluation of Mathematical Models for Temperature Prediction in Deep Reservoirs BY F. L. Parker, B. A. Benedict, and C. Tsai, Vanderbilt University Nashville, TN

The deep reservoir model with one-dimensional assumptions can be applied to a reservoir or lake where the principal variation of flow characteristics is in the vertical direction. Among the models evaluated, the MIT deep reservoir model appears to be most easily used and to give results most compatible with the measured temperatures. The temperature predicted is strongly dependent upon the magnitude of the absorption coefficient of water, and the diffusion coefficient. However, our sensitivity analysis shows that an absorption coefficient of about $0.75m^{-1}$ and a diffusion coefficient of 15 to 20 times molecular diffusion are appropriate choices for the seven TVA reservoirs studied. The determination of whether or not a reservoir model depends on the Densimetric Froude number. However, the representativeness of the result is not solely dependent upon the Densimetric Froude number. By the use of a fitted curve to the measured temperatures, it was possible to determine the maximum standard error of estimate for the predicted outlet level temperature, 1.6 degrees C. Temperatures on individual days may exceed these values and they surely are exceeded at other depths in the reservoir. These limits are suggested as the limit of accuracy of these types of models. EPA CONTACT: Tichenor, B.

NEW REPORT ABSTRACTS SECTION

660/4–75–003 PE 1BA027 ROAP/TASK 16 ADN 37 IN-HOUSE PROJECT

Isolating Organic Water Pollutants: XAD Resins, Urethane Foams, Solvent Extraction BY R. G. Webb, Southeast Environmental Research Laboratory, EPA Athens, GA

Isolation, separation, and concentration into an organic solvent are generally required prior to identification and quantitation of organic pollutants in water by gas chromatography or mass spectrometry. These operations can be simplified or improved by the use of XAD-resins (macroreticular resins) and by changes in solvent extraction procedures. XAD-2, 4, 7 and 8 and mixtures of these resins effectively extracted a broad range of individual industrial pollutants and mixtures typical of paper mill wastewater, dissolved fuel oil, and textile dyes. Resin recovery efficiencies were typically 65–75% for individual compounds; direct chloroform extraction efficiency was 80%. Polyurethane foams were not effective for extracting these compounds. Chloroform is generally recommended over diethyl ether as an extraction solvent. Drying of chloroform extracts before evaporation was shown to be unnecessary. For typical industrial effluents, extract concentration to 10 ml with a Kuderna-Danish evaporator and to as low as 0.3 ml with a micro-Snyder column is the most quantitative procedure. Extraction with micro-Snyder column is the most quantitative procedure. Extraction with tetralin sometimes allows detection of nonpolar low-boiling pollutants that are usually obscured in gas chromatographic analysis by the solvent peak.

660/4–75–004 PE 1BA027 IN-HOUSE PROJECT

Environmental Applications of Advanced Instrumental Analyses: Assistance Projects, FY 74 BY A. L. Alford, Southeast Environmental Research Laboratory, EPA Athens, GA

The Analytical Chemistry Branch of the Southeast Environmental Research Laboratory identified and measured aquatic pollutants under seven projects in anser to requests for assistance from other EPA organizations and other government agencies. In most cases these analyses helped to solve, or at least to understand more clearly, the related pollution incident and in some cases provided evidence for enforcement of regulatory legislation. Under an additional project, analytical consultations were held as requested by various organizations concerned with pollution incidents.

660/4–75–005 PE 1BA027 ROAP/TASK 07 ABL 02 IN-HOUSE PROJECT

Analysis of Organic Compounds in Two Kraft Mill Wastewaters BY L. W. Keith, Southeast Environmental Research Laboratory, EPA Athens, GA

Wastewaters from two kraft paper mills in Georgia were sampled at various points in the waste treatment systems. Gas chromatography of the organic extracts and identification of many of the specific chemical components by gas chromatography-mass spectrometry provided a "chemical profile" of the effluents. The mills, in different geographical locations, have very similar raw wastewater compositions but different wastewater treatments. In spite of these differences, the treated effluents are qualitatively similar in composition although the quantities of the various components differ. After two years the raw and treated effluents of both mills were re-sampled. Analyses showed that although concentrations of the organics varied, the same compounds are still present.

670/1–75–001 PE 1CA046 ROAP/TASK 21 APV 03 CONTRACT NO. 68–03–0126

Evaluation of Semipermeable Membranes for Concentration of Organic Contaminants in Drinking Water BY I. Cabasso, C. S. Eyer, E. Klein, and J. K. Smith, Gulf South Research Institute New Orleans, LA

Membrane separation principles have been examined and tested for the separation of trace organic solutes from drinking water to facilitate toxicological sample preparation. Five membrane materials have been evaluated through experiment and through review of the literature. The membranes included cellulose acetate, cellulose acetate butyrate, ethyl cellulose, polyamide, and polyurea (NS-1). An extensive literature review, screening the performance of the membranes toward separation of the vast majority of organics potentially present in drinking water, is given. Experimental concentrations of selected solutes were carried out in an osmotic concentrator designed during this study. From separation experiments with cellulose acetate membrane, two classes of organic compounds (classified according to their response in the separation system) were identified. One class of compound shows increasing separation with increasing applied pressure; the other class shows anomalous response of separation to increasing pressure, with some solutes maintaining constant rejection, and others showing decreased rejection with increased pressure. To study the separation mechanism, permeability coefficients and distribution coefficients (of solutes between membrane and water) were measured. The main conclusion derived from this approach was that high water-solute coupling occurs in transport. Polyamide and polyurea (NS-1) were shown to yield high separation and low permeability compared to the cellulosic type membrane. Concentration of large volumes of water by a factor of 10X using reverse osmosis, followed by a further concentration of 50X with the osmotic concentrator is shown to be a reasonable approach to sampling large volumes of drinking water for toxicological analysis of the residues. EPA CONTACT: Kopfler, F. C.

NEW REPORT ABSTRACTS SECTION

670/2–75–010 PE 1BB034 ROAP/TASK 21 ASY 149 GRANT NO. 11023 FAR

Multi-Purpose Combined Sewer Overflow Treatment Facility, Mount Clemens, Michigan BY V. U. Mahida, and F. J. DeDecker, Mount Clemens, City of Mount Clemens, MI

Combined sewer overflows from 212 acres within the City of Mount Clemens were conveyed to a treatment-park site. The overflows received initial treatment (settling and surface aeration) in a retention basin. Further treatment consisted of microstraining, disinfection, surface aeration in a series of lakelets, and filtration. The annual existing overflow of 2180 cu ft/acre-inch of rainfall had SS of 50 lbs/acre-inch and BOD_5 of 20 lbs/acre-inch. Treatment reduced the annual pollution load by 90 percent . The final lake sampling data has demonstrated that all water quality parameters for fishing, boating, and/or lawn sprinkling—except the toxic and deleterious substances parameters, which were not studied—were met. Very limited investigations were undertaken in the area of recreation, open space, and transitional land use. Treatment of combined sewer overflows was found to be more cost-effective than separation of an existing combined sewer system. EPA CONTACT: Field, R. 201–548–3503

670/2–75–040 PE 1DB314 ROAP/TASK 24 AIN 06 GRANT NO. 800786

Design and Performance Considerations for a Pilot Process for Separating Mixed Municipal Refuse BY D. G. Wilson, and S. D. Senturia, Massachusetts Institute of Technology Cambridge, MA

Separating municipal solid waste into its valuable and recycleable elemental components is examined here in terms of various mechanical engineering schemes and processes that might best accomplish this task. Although past efforts have concentrated on first reducing the particle size by shredding, this investigation considered the advantages of whole-item coding and sorting without the expensive shredding operation. The result was an interesting base technology for a proposed pilot plant design that could potentially redirect future resource recovery efforts in solid waste. EPA CONTACT: Oberacker, D. A. 513–684–4484

670/2–75–042 PE 1BB041 ROAP/TASK 21 AVN 33 CONTRACT NO. 68–01–0110

Methods to Treat, Control and Monitor Spilled Hazardous Materials BY R. J. Pilie, R. E. Baier, R. C. Ziegler, R. P. Leonard, J. G. Michalovic, S. L. Pek, and D. H. Bock, Calspan Corporation Buffalo, NY

A program was instituted to study the feasibility of treating, controlling and monitoring spills of hazardous materials. Emphasis was placed on considering techniques and equipment which would be applicable to general classes of chemicals rather than to specific hazardous polluting substances. Several methods were investigated and found to be promising for removing or detoxifying spills of hazardous chemicals "in situ". These included: the use of sodium sulfide as a precipitating agent for spills of heavy metal ion solutions; the use of activated carbon packaged in porous fiber bags (carbon "tea bags") for adsorbing a wide variety of soluble organic chemicals; and the use of various acids or bases to neutralize spills. Methods were studied to control spills on land and prevent their contaminating nearby surface or ground water. To this end, a four-component "universal gelling agent" was developed to immobilize a spilled liquid. A "cyclic colorimeter", a novel heavy metal ion detector, was perfected and laboratory tested, and a detection kit capable of sensing several chemicals was developed. A computer model was developed and refined to simulate the spread of a spill when certain stream parameters and material characteristics are known. Bioassay studies were conducted for several chemicals using at least three species of biota. In addition, bioassays were conducted to estimate the environmental effect of each of the various treatment methods developed. EPA CONTACT: Lafornara, J. P. 201–548–3523

670/2–75–045 PE 1BB043 ROAP/TASK 21 ASR 39 CONTRACT NO. 68–03–0102

Replacement of Activated Sludge Secondary Clarifiers by Dynamic Straining BY M. Joyce, W. Schultz, and A. Strom, FMC Corporation Itasca, IL

Pilot plant studies were conducted on domestic wastewater to determine the feasibility of replacing conventional activated sludge gravitational clarifiers by dynamic straining. The dynamic strainers consisted of a rotating cylinder cleaned by an internal ultrasonic transducer. A primary strainer was placed and operated directly in the mixed liquor in the aeration tank. A secondary strainer was installed and operated in a separate tank to further clarify the effluent from the primary strainer. This work indicated that dynamic straining is a technically feasible process for replacing conventional activated sludge gravitational clarifiers. Suspended solids removals of well over 99 percent were achieved with a single primary strainer operating in the pilot plant aerator with a mixed liquor suspended solids concentration of over 6,500 mg/1. When operated at lower specific flow rates, primary straining appears to be capable of consistently producing an effluent suspended solids in the 15–30 mg/1 range. Present economic predictions indicate that plants equipped with primary and secondary dynamic strainers would cost more than plants utilizing conventional secondary gravity clarifiers. This factor can be tempered by several projected dynamic straining advantages. EPA CONTACT: Brenner, R. C. 513–684–8362

NEW REPORT ABSTRACTS SECTION

670/2-75-046 PE 1BB034 ROAP/TASK 21 ATB 08 GRANT NO. 800941

Rainfall-Runoff Relations on Urban and Rural Areas BY E. F. Brater, and J. D. Sherrill, Michigan, University of Ann Arbor, MI

A procedure was developed for estimating the frequency of storm runoff of various magnitudes from rainfall and/or snowmelt on small drainage basins in various stages of urbanization. The study was based primarily on the analysis of storm runoff events on real basins varying in size from 0.02 to 734 sq mi. The method is based on applying unit hydrographs to precipitations of various frequencies after deducting infiltration and retention. A concurrent study with an analytical drainage basin model provided additional understanding of the effects of some parameters. The unit hydrograph-infiltration capacity concept was selected as the most accurate practical method for predicting storm runoff. It was found that the form of the unit hydrograph could be related to drainage basin size and degree of urbanization as measured by population density. Other characteristics of the drainage basin are much less important. The form of the unit hydrograph stays relatively constant for various durations and magnitudes of input as long as the duration of input is smaller than a critical time which can also be related to the size and population density of the basin. As the population increased from rural to highly urbanized, peak discharges for the same runoff became as much as ten times greater. Infiltration capacity was found to vary seasonally. The prediction of flood frequency by this procedure is fully operable for Southeastern Michigan. For application to other areas some hydrograph aanalysis must be made. EPA CONTACT: Cesareo, D. J.

670/2-75-047 PE 1BB040 ROAP/TASK 61 AAD 16 CONTRACT NO. 68-01-0465

Up-Dip Versus Down-Dip Mining: An Evaluation BY J. W. Mentz, and J. B. Warg, Skelly & Log, Engineers Harrisburg, PA

The report presents detailed results of a feasibility study of down-dip mining, a technique that appears to offer an alternative to sealing or permanent treatment of polluted effluents from coal mines after abandonment. The project included an evaluation of a pair of nearly identical abandoned underground mines – one developed to rise, one developed to dip – to confirm the theory that discharge water quality in down-dip mines is substantially better than that in up-dip mines. An active mine with units operating up-dip and down-dip was also evaluated to ascertain economic and engineering limitations, costs in varying situations, and other major advantages or disadvantages of each mode of operation. Health and safety and National water quality and economic impacts of widespread use versus non-use of the technique were also assessed. EPA CONTACT: Harris, E. F. 513-684-4417

670/2-75-048 PE 1BB040 ROAP/TASK 21 BDU 02 GRANT NO. 802621

Water Quality Control in Mine Spoils — Upper Colorado River Basin BY D. B. McWhorter, R. K. Skogerboe, and G. V. Skogerboe, Colorado State University Fort Collins, CO

The purpose of this study was to identify potential water quality problems associated with runoff and percolation through mine spoils at selected sites in the Upper Colorado River Basin. The results show that the production of soluble salts from mine spoils into receiving waters is probably the most significant water quality problem that can be expected. No significant release of heavy metals was observed in the coal mine spoils studied. Some significant heavy metal concentrations were observed in the stream below the tailings disposal area from a copper-leadzinc mill. A portion of these metals are contributed by the tailings, but a variety of old mines and mine dumps also make a contribution. The quality of percolate and runoff from spoils was found to correspond to the constituents of extracts prepared from saturated pastes of the spoil material. A method of estimating salt production into receiving waters was derived and found to agree very well with measured salt pickup at one coal site. The minimum quantitites of salts that will eventually be released from the spoils studied are estimated. EPA CONTACT: Grim, E. C. 513-684-4417

670/2-75-049 PE 1BB043 ROAP/TASK 21 ASE 11 CONTRACT NO. 68-03-0140

Review of Landspreading of Liquid Municipal Sewage Sludge BY T. E. Carroll, D. L. Maase, J. M. Genco, and C. N. Ifeadi, Battelle Memorial Institute Columbus, OH

The objective of this study was to review and summarize existing information regarding landspreading of liquid municipal sewage sludge. An extensive literature review was conducted and an annotated bibliography is available as a separate report from the NTIS. Emphasis was also given to obtuining information concerning the number of sewage treatment plants currently using landspreading. A questionnaire survey of 1909 sewage treatment plants in Federal Regions 2, 3, 4, 5, and 9 was conducted and selected operations were visited. The information and data gathered during the study are summarized relative to sludge characteristics, sludge handling and distribution systems, economics of landspreading, sludge-soil-plant interactions, public health considerations, land acquisition, and survey of sewage treatment plants. The survey indicated that about 21 percent of the plants in the study regions are using landspreading routinely. Sixty-eight percent of the plants using landspreading have been conducting the practice for less than ten years. Of this 68 percent, over two-thirds have begun the practice only within the last five years. EPA CONTACT: Dotson, G. K. 513-684-8275

NEW REPORT ABSTRACTS SECTION

670/2-75-050a PE 1CB047 ROAP/TASK 21 AQB 24 CONTRACT NO. DACW 37-74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Summary Report Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fiber counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study, engineering data were also obtained for making cost estimates for construction and operation and both granular and diatomaceous earth (DE) media filtration plants ranging in size from 0.03 to 30 mgd. Both dual and mixed-media granular filters using alum and nonionic polymer, employing flash mix and flocculation without settling and DE filters with alum coated DE as precoat and/or body feed or with Catfloc B added to raw water, produced effluents with amphibole fiber counts below electron microscope detection limits. Turbidity was not a direct measure of fiber count, but amphibole counts were generally lowest at effluent turbidities less than or equal to _ 0.1 TU. Chrysotile removal was more difficult, but mixed media granular filtration with alum and nonionic polymer, and DE filtration with anionic polymer conditioned DE frequently reduced chrysotile fiber counts markedly. Systems for economic reasons recommended for consideration during design studies are (1) mixed media direct filtration, 5gpm/sq ft, multiplestage flash mix; (2) dual media filtration, 4 gpm/sq ft, single stage flash mix; and (3) pressure DE filtration, 1 gpm/sq ft, alum conditioning of precoats and body feed, or alum conditioning of precoat only, and cationic polymer fed to raw water. EPA CONTACT: Logsdon, G. S. 513-684-8305

670/2-75-050b PE 1CB047 ROAP/TASK 21 AQB 24 CONTRACT NO. DACW 37-74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix A. Weather and Lake Level Data, Water Quality Data, and Raw Water Pumping Schedule Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fiber counts in Lake Superior water would be effectively reduced by municipal filtration plants. During the study, engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30 mgd. This appendix contains a portion of the data collected in the study. The following categories of information are presented in Appendix A: (1) Weather and lake level data; (2) Operating schedule for pumps at the pumping station; (3) Chemical and physical quality parameters of raw and filtered water; (4) Dissolved oxygen content of raw and finished water; and (5) Bacteriological data for raw and finished water. EPA CONTACT: Logsdon, G. S. 513-684-8305

670/2-75-050c PE 1CB047 ROAP/TASK 21 AQB 24 CONTRACT NO. DACW 37-74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix B. Design, Installation and Operation of Pilot Filters. Appendix C. Summary of Data for Individual Filter Runs Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fiber counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study, engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30 mgd. Appendix B contains information on the pilot filters used in the study. Data are presented on the physical aspects of the units (dimensions and equipment configuration) and on the manner in which the filters were operated. Appendix C contains data obtained during the individual pilot plant filter runs. This kind of information will be useful to persons needing to know about specific conditions such as raw water turbidity, filtration rate, and chemical doses or diatomaceous earth types and amounts used for precoat or body feed. EPA CONTACT: Logsdon, G. S. 513-684-8305

670/2-75-050d PE 1CB047 ROAP/TASK 21 AQB 24 CONTRACT NO. DACW 37-74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix D. Head Loss and Turbidity Curves for Individual Filter Runs Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fiber counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study, engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30 mgd. In Appendix D, all graphs of filter head loss and effluent turbidity as functions of the number of hours of filter operation are given. These graphs and the individual filter run data presented in Appendix C could be used to evaluate filter performance under circumstances in which the production of clear, potable water is the goal, rather than the removal of asbestiform fibers. EPA CONTACT: Logsdon, G. S. 513-684-8305

NEW REPORT ABSTRACTS SECTION

670/2–75–050e   PE 1CB047   ROAP/TASK 21 AQB 24   CONTRACT NO. DACW 37–74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix E. Ontario Research Foundation Electron Microscope Analysis Results. Appendix F. EPA National Water Quality Laboratory X-Ray Diffraction Analysis Results. Appendix G. University of Minnesota at Duluth Electron Microscope Analysis Results Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fiber counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30mgd. Data provided to the contractor by the Ontario Research Foundation are presented in Appendix E. ORF performed asbestiform fiber analysis of water samples by the transmission electron microscope method in this project. In order to place the data in better perspective, a description of the analytical method used by ORF is reproduced in Appendix E. In Appendix F, the amphibole mass data obtained by the National Water Quality Laboratory in Duluth are presented. This appendix also includes information on the analytical method used at NWQL. The x-ray diffraction analysis for amphibole mass provided confirmation of electron microscope amphibole fiber results. Fiber count data obtained at the University of Minnesota at Duluth are tabulated in Appendix G. A statement describing the electron microscope analytical method is also included. EPA CONTACT: Logsdon, G. S. 513–684–8305

670/2–75–050f   PE 1CB047   ROAP/TASK 21 AQB 24   CONTRACT NO. DACW 37–74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix H. Comparison of Turbidimeters Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrate that asbestiform fiber counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study, engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30 mgd. During the pilot plant research, three different turbidimeters were utilized in order to compare 90 degrees scatter instrumentation with 15 degrees forward scatter instrumentation. The data from this comparative study are in Appendix H. EPA CONTACT: Logsdon, G. S. 513–684–8305

670/2–75–050g   PE 1CB047   ROAP/TASK 21 AQB 24   CONTRACT NO. DACW 37–74

Direct Filtration of Lake Superior Water for Asbestiform Fiber Removal – Appendix I. Diatomite Filters for Asbestiform Fiber Removal from Water Black & Veatch Consulting Engineers Kansas City, MO

Pilot plant research conducted in 1974 at Duluth, Minnesota, demonstrated that asbestiform fibers counts in Lake Superior water could be effectively reduced by municipal filtration plants. During the study engineering data were also obtained for making cost estimates for construction and operation of both granular and diatomaceous earth (DE) filtration plants ranging in size from 0.03 to 30 mgd. During one phase of the pilot plant investigation, the diatomite filters were operated in a way that yielded data used for computer optimization of the DE filtration process. The POPO (Program for Optimization of Plant Operation) results are presented in Appendix I. EPA CONTACT: Logsdon, G. S. 513–684–8305

670/2–75–051   PE 1BB043   ROAP/TASK 21 ASP 26   CONTRACT NO. 68–01–0162

Single-Stage Nitrification-Denitrification BY D. F. Bishop, J. A. Heidman, and J. B. Stamberg, National Environmental Research Center, EPA Cincinnati, OH

The removal of 75–84% of the nitrogen from primary wastewaters was achieved in a single stage activated sludge process. The twopass reactor was operated with a food to mass ratio (F/M) of approximately 0.1 gm BOD$_5$/day/gm MLVSS. The air was applied on a 30-minute cycle first to one reactor pass then to the other pass. Mechanical mixers suspended the mixed liquor solids when the air was not applied. The D.O. concentration varied from 0.0 mg/1 without air to 2–3 mg/1 during aeration. In June with a 9-hour detention time in the reactor, the residual pollutant concentrations averaged 23 mg/1 of COD (90% removal), 3.8 mg/1 of total nitrogen (84% removal) and 7.8 mg/1 of suspended solids (93% removal). In February, with a 12-hour reactor detention time, the residual pollutants averaged 25 mg/1 of COD (89% removal), 6.0 mg/1 of Total N (75% removal) and 14 mg/1 of suspended solids (87% removal). Since the nitrate from nitrification was used to remove BOD$_5$ from the wastewater, the process advantages for single stage nitrification-denitrification included the reduction in the amount of air needed to achieve BOD$_5$ removal and nitrification; the minimizing of supplemental organic carbon sources for denitrification; and the elimination of clarifiers in staged nitrification-denitrification. EPA CONTACT: Bishop, D. F. 513–684–8353

NEW REPORT ABSTRACTS SECTION

670/2-75-052 **PE 1BB043** **ROAP/TASK 21 ASO 17** **CONTRACT NO. 68-01-0162**

Carbon, Nitrogen, and Phosphorus Removal in Staged NitrificationDenitrification Treatment BY J. A. Heidman, D. F. Bishop, and J. B. Stamberg, National Environmental Research Center, EPA Cincinnati, OH

A three-stage activated sludge system with mineral addition for nutrient removal was operated with District of Columbia primary effluent. Influent flow followed a programmed diurnal cycle and averaged 54,000 gpd. The first biological reactor was operated as a modified aeration system with ferric chloride addition for supplemental phosphorus removal. The clarified effluent then flowed to the second reactor for the biological nitrification of ammonia and organic nitrogen. Dry lime was used for pH control. Methanol was added to the nitrified effluent, and biological denitrification occurred in the final activated sludge system. Prior to clarification, the denitrification effluent was briefly aerated for nitrogen gas removal and for consumption of any excess methanol. The clarified effluent was then split into two equal streams for comparison of filtration performance of a dual-media coal and sand filter with that of a multi-media coal, sand, and ilmenite filter. Effluent quality consistently met the proposed D.C. discharge standards of BOD 8 C 4.5 mg/1; total N 2.5 mg/1; and P 0.22 mg/1. EPA CONTACT: Bishop, D. F. 513-684-8353

670/2-75-055 **PE 1BB036** **ROAP/TASK 21 AZO 17** **GRANT NO. 802113**

Removal of Chromium from Plating Rinse Water Using Activated Carbon BY R. B. Landrigan, and J. B. Hallowell, Battelle Columbus Laboratories Columbus, OH

Chromium is a major pollutant in wastewaters from some electroplating operations. It can be effectively removed from rinse waters by adsorption on activated carbon, which must be regenerated when saturated with chromium to its upper limit. This study was concerned with the best means of regenerating the carbon under conditions which would return it as closely as possible to its original adsorptive capacity. The tests were conducted (1) on a laboratory scale to determine the effects of basic and acidic media on regeneration of chromium-loaded activated carbon and (2) in a small pilot plant unit on the basis of the best results of the laboratory-scale work. In the latter case, tests were conducted on the unit operation for eight adsorption-desorption cycles. The overall results of this study suggest that a chromium removal unit could be installed in many of the small plating plants, relieving the burden on municipal sewage systems, and bringing the plating plant into compliance with local and Federal regulations. Recommendations for improvement of the regeneration process are given even though the process could be used in its present stage of development. EPA CONTACT: Wilson, D. 513-684-4248

670/2-75-056 **PE 1BB041** **ROAP/TASK 21 AVJ 04** **GRANT NO. 800650**

Preliminary Design of a Comprehensive Waste Oil Processing Facility BY G. D. Gumtz, and E. J. Martin, Environmental Quality Systems, Inc. Rockville, MD

A preliminary design is presented for a comprehensive waste oil recovery and disposal facility for the State of Maryland. The base for this design was an annual state-wide waste oil generation of 22,000,000 gallons which includes all known waste oil sources. With a 90 percent stream factor, feed to the plant is 66,000 gallons per day. EPA CONTACT: Lederman, P. B. 201-548-3402

670/2-75-057 **PE 1BB041** **ROAP/TASK 21 AVO** **CONTRACT NO. 68-01-0098**

Guidelines for the Disposal of Small Quantities of Unused Pesticide BY E. W. Lawless, T. L. Ferguson, and A. F. Meiners, Midwest Research Institute Kansas City, MO

This study has compiled and organized information that will be useful to responsible authorities in advising the layman (particularly the homeowner and small farmer) how to dispose properly of small amounts of surplus and unwanted pesticides and pesticide containers, and in treating pesticide spills. The report brings together available information on pesticide disposal methods and on over 550 individual pesticides, and evaluates this information in terms of the experience and equipment that the average layman has. Fourteen pesticide disposal procedures are described and procedures for disposal of containers and cleanup and treatment of spills are included. Preferred and alternate disposal procedures are recommended for over 550 pesticides. The report includes a cross-index of over 1,600 pesticide names, tables showing the chemical composition and properties pertinent to disposal of the selected pesticides and bibliography of 166 references. EPA CONTACT: Brugger, J. E. 201-548-3506

NEW REPORT ABSTRACTS SECTION

670/2-75-058 **PE 1DB314** **ROAP/TASK 21 BFS 17** **GRANT NO. 803111**

Environmental Assessment of Future Disposal Methods for Plastics in Municipal Solid Waste BY D. A. Vaughan, C. Ifeadi, R. A. Markle, and H. H. Krause, Battelle Columbus Laboratories Columbus, OH

Production of plastics for engineering and consumer items in the United States has been predicted to reach 113 million tons per year by the year 2000. This figure does not include the production of polymer used for synthetic fiber or fabric. From 31 to 38 million tons of the plastic produced is expected to reach the solid waste stream, depending on the basis of estimation. The largest amount will go to sanitary landfills, and the next largest amount will be thermally treated using such methods as power generation, incineration, and pyrolysis. Small amounts of plastic are expected to be disposed of in open dumps or as litter. Resource recovery for plastics in municipal refuse up to the year 2000 is expected to be insignificant. Air pollution as a result of plastics in the landfills and open dumps will be negligible, even if there is still some burning of open dumps in 2000. EPA CONTACT: Oberacker, D. A. 513-684-4484

670/2-75-059 **PE 1BB041** **ROAP/TASK 21 BEA 08** **GRANT NO. 803063**

Oil Spill and Oil Pollution Reports, February 1975 – April 1975 BY F. A. DeWitt Jr., and P. Melvin, California, University of Santa Barbara, CA

This report is the third quarterly compilation of oil spill events and oil pollution report summaries. Presented in the report are: (a) summaries of oil spill events; (b) summaries and bibliographic literature citations; (c) summaries of current research projects; and (d) patent summaries. EPA CONTACT: Dorrler, J. S. 201-548-3508

670/2-75-060 **PE 1BB043** **ROAP/TASK 21 ASW 08** **GRANT NO. 11010 DYO**

Controlling Sulfides in Sanitary Sewers Using Air and Oxygen BY R. J. Sewell, Port Arthur, City of Port Arthur, TX

This report documents ambient sulfide conditions and corrosion rates in a sanitary sewerage system, and presents the results of a study that demonstrated that the use of air or pure oxygen were effective in controlling sulfides. The three techniques used to entrain the gases in the sewage included injection, U-Tubes, and pressure tanks. Sulfide control was evaluated at eight separate locations involving lift stations, force mains, and receiving gravity lines. The entrainment techniques studied were not optimized. However, odor and corrosion problems were abated. Preliminary cost data indicated that air injection into force mains, and the use of air with the U-Tube were the least costly sulfide control measures. EPA CONTACT: English, J. N. 513-684-8346

670/2-75-061 **PE 1BB038** **GRANT NO. 801799**

Analysis of Emissions from Outboard Two Cycle Marine Engines BY W. J. Weber Jr., D. E. Cole, and J. C. Posner, Michigan, University of Ann Arbor, MI

The work herein reported is the University of Michigan's contribution to a larger scope study dealing with the environmental impacts of outboard engine usage on small lake systems. This part of the total project is concerned with laboratory investigations, two other groups being involved with field studies. A wide variety of two-stroke engines were run under load conditions and the emissions, both condensable and noncondensables, analyzed. The influence of maintenance on emissions was also examined and found to have little effect. Crankcase drainage constituted only a small fraction of the total hydrocarbons emitted and was enriched in oil over the fuel. Exhaust products which one could reasonably expect to be condensable in a water-column constituted less than 10% of fuel fed in all cases and usually considerably less. The major portion of the water condensable aromatics evaporated fairly rapidly from the receiving water, but a portion was nonvolatile. Analytical methods for field study were developed and the toxicity of both condensed exhaust and individual compounds in gasoline to goldfish were determined. EPA CONTACT: McCarthy Jr., L. T. 201 548-3594

670/2-75-062 **PE 1BB038** **GRANT NO. 801799**

Analysis of Pollution from Marine Engines and Effects on the Environment Environmental Control Technology Corporation Ann Arbor, MI

The objective of this study was "to obtain sufficient laboratory and field data to be able to predict the number of outboard engines which can be operated on any particular body of water without causing adverse effects on the aquatic environment." To achieve this objective four small natural bodies of water were subjected to outboard engine emissions three times greater than saturation (maximum) levels occurring under "real world" boating conditions. These natural water bodies were stressed at these high levels with outboard engine exhaust emissions for a period of three years. The study showed that there were no "dramatic" or acute changes in the physical, chemical or biological characteristics of the water or sediments of the test lakes at these high stressing levels. EPA CONTACT: McCarthy Jr., L. T. 201-548-3594

NEW REPORT ABSTRACTS SECTION

670/2-75-063 PE 1BB038 GRANT NO. 801799

Analysis of Pollution from Marine Engines and Effects on the Environment – Southern Lakes BY H. L. Davis, and K. D. Wilson, Environmental Science and Engineering, Inc. Gainesville, FL

This study was conducted to determine the effects of two-cycle outboard engine emissions on Florida lakes using leaded fuel and drained and drainless engines. Field investigations were performed in three natural lakes of 2 to 10 acreas near Gainesville, Florida. One lake was treated with "drainless" engines and one with engines which "drained" unburned fuel into the water. The third lake served as a control. Biological components and water quality conditions in the three lakes were monitored by routine standard procedures for a time period of 18 months during which motors were operated at the rate of 2.4 gallons of fuel per million gallons of water per day. During the course of the field investigation, there was no overt evidence of any significant effect of motor emissions on the benthic macroinvertebrates, phytoplankton, periphyton, and fish taste; although the data indicated that plant production in the grassbeds may have increased as a result of engine operation. This increase in plant production was evident during the growing season when the availability of carbon dioxide limited plant growth in the grassbed community. EPA CONTACT: McCarthy Jr., L. T. 201-548-3594

670/2-75-064 PE 1BB038 GRANT NO. 801799

Analysis of Pollution from Marine Engines and Effects on the Environment – Summary Report Boating Industry Association Chicago, IL

This is a *Summary Report* of a research project which involved laboratory and field investigations. The laboratory phase was conducted by the departments of Civil and Mechanical Engineering of the University of Michigan. The northern lakes—field study was conducted by Environmental Control Technology Corporation, Ann Arbor, Michigan. The southern lakes—field study was conducted by Environmental Science and Engineering, Inc., Gainesville, Florida. To achieve the project objective four ponds were subjected to outboard engine emissions at a rate calculated to be three times greater than that from saturation boating levels. Some marginal changes in the lakes biota were noted but the differences were such that it is not certain whether they were from natural or stress effects. As a result it was not possible to determine conclusively the precise point at which outboard emissions effect the aquatic environment. Based on the results, it is plausible to conclude, however, that because of the high stress levels employed in this study, outboard motor emissions do not significantly affect aquatic ecosystems. EPA CONTACT: McCarthy Jr., L. T. 201-548-3594

670/2-75-065 PE 1BB034 ROAP/TASK 21 ATA 26 GRANT NO. 803069

Short Course Proceedings: Applications of Stormwater Management Models BY F. A. DiGiano, and P. A. Mangarella, Massachusetts, University of Amherst, MA

This Short Course was sponsored by the U.S. Environmental Protection Agency. The specific objectives were to encourage the consulting profession to implement stormwater models in solving the problem of storm and combined sewer overflows and to make state pollution control agencies aware of this tool in their pollution abatement efforts. Emphasis was placed on presentations of various types of models, their data requirements and case studies of their use. The EPA Stormwater Management Model (SWMM) was highlighted. It is hoped that this compilation of instructional papers, prepared by the Short Course faculty, will enable practicing engineers to broaden their use of stormwater management models. The Short Course was held at the University of Massachusetts August 19–23, 1974. Registration totaled 81 with representation by consultants; Federal, State and Municipal engineers, including the Canadian government; and University researchers. EPA CONTACT: Fan, C.

670/2-75-066 PE 1BB041 ROAP/TASK 21 ANT 15 CONTRACT NO. 68-03-0327

Surface Effects Skimmer Development BY N. P. Trentacoste, Science Applications, Inc. McLean, VA

This experimental program investigated the use of a Surface Effects Skimmer in removing thin film oil slicks spread over large water areas by fast currents. This new skimmer uses a directed air jet to separate and lift spilled oil from the surface of the water in the form of a spray consisting of oil and water droplets. The oil/ water spray is directed toward a rotating belt of polyurethane foam from which it is squeezed and pumped to a nearby storage tank. Initial experiments were performed in a 20 cm wide flume. Subsequent tow tank tests were conducted at speeds up to 3.25 knots in calm, choppy and smooth wave conditions with oils ranging from a very viscous Venezuelan crude to a very light No. 4 distillate fuel oil. During tests at a tow speed of 3.25Kts in the presence of 13.75 cm high waves oil collection efficiencies of more than 80% were achieved with the Venezuelan crude oil and of about 60% with the No. 4 distillate fuel oil. In a related series of experiments, it was found that presoaking the polyurethane foam belt in either water or oil had no effect on its ability to retain oil. EPA CONTACT: Farlow, J. S.

NEW REPORT ABSTRACTS SECTION

670/2-75-067 PE 1BB034 ROAP/TASK 21 ASY 38 CONTRACT NO. 68-03-0262

Automatic Organic Monitoring System for Storm and Combined Sewers BY A. Tulumello, Raytheon Company Portsmouth, RI

Early in the program to develop a stormwater TOC (total organic carbon) system, it was established in report EPA-670/2-74-087 that continuous on-line TOC was the best method for the measurement of stormwater pollution loading. Hardware was assembled that would process stormwater samples containing high suspended solids and that would obtain a continuous signal proportional to the concentration of TOC in the sample. Synthetic samples of municipal raw influent charged with primary sludge were analyzed using the TOC analyzer. Data were also obtained on actual stormwater samples collected during storm events at Boston. Further modifications were made after these observations. Automatic circuitry designed to provide turn on, auto-zero, autospan and sample line flushing was added to the hardware, and the system was installed at Boston Cottage Farm Storage Facility. Automatic continuous analyses were obtained during storms on site at the Cottage Farm Storage Facility. EPA CONTACT: Masters, H.E.

670/2-75-068 PE 1BB041 ROAP/TASK 21 AVJ 06 CONTRACT NO. 68-01-0177

Recycling of Waste Oils BY S. Maizus, National Oil Recovery Corporation Bayonne, NJ

The objective of the work reported is the development of technology to recycle waste oils to useful products, without producing undesirable wastes. Both crankcase and other waste oils were studied in the laboratory and in a 1000 barrel per day vacuum distillation process operated by National Oil Recovery Corporation in Bayonne, New Jersey. Plant operations demonstrated that vacuum distillation is a suitable process for producing fuels from a wide variety of waste oils. Laboratory and engineering studies showed that the distillate side product produced from crankcase waste oil could be catalytically hydrotreated to produce a lube with good odor, color, and stability characteristics. Overall, the vacuum distillation/hydrogen treatment process for re-refining waste oils holds great promise. The distillation bottoms, containing high concentrations of lead and other metals, can be used as a fuel in secondary lead smelting. Pretreatment and chemical reduction agents show promise in refining, but additional laboratory and evaluation work is required. EPA CONTACT: Tabakin, R. B.

670/9-75-002 PE 1RA103 IN-HOUSE PROJECT

NERC-Cincinnati Annual Report, 1974 Technical Information Staff, NERC Cincinnati, OH

Research activities of each of the NERC-Cincinnati laboratories are summarized, and a number of contributions made by our staff members to international activities of the EPA are highlighted. Certain projects from the research activities have been chosen for special mention in the text. As this report clearly indicates, FY 1974 has witnessed a significant step forward in the Cincinnati mission to develop pollution control technology in the areas of municipal and industrial waste treatment, municipal water supplies and systems, solid and hazardous waste disposal, pollution identification methodology and monitoring, and toxicological health effects. EPA CONTACT: Gigliotti, G. M. 513-684-8259

670/9-75-005 PE 1RA103 IN-HOUSE PROJECT

Third U.S. — Japan Conference on Sewage Treatment Technology, Proceedings, February 12 – 16, 1974 National Environmental Research Center, EPA Cincinnati, OH

At the Third U.S.-Japan Conference on Sewage Treatment Technology, the Japanese delegation presented a series of papers expressing views on the Federal Water Pollution Control Act Amendments of 1972, specifically of the water quality and effluent standards and grants for construction of treatment works; detailing research done and problems encountered in the heat treatment of sewage sludge; outlining the feasibility of combined treatment of municipal and industrial wastewater; and reporting the status of studies being done on advanced waste treatment. Members of the U.S. delegation presented State and Federal viewpoints on the Federal Water Pollution Control Act Amendments of 1972; the overall EPA wastewater treatment research program; sludge treatment and disposal guidelines for municipal wastewater plants in the United States; methods of wastewater treatment by physical-chemical nitrogen removal; experiences with sludge handling and oxygen activated sludge systems in Texas; studies on aeration systems, suspended solids removal processes, and nitrification conducted in the Metro Chicago; and EPA experiences in oxygen activated sludge. EPA CONTACT: Gigliotti, G. M. 513-684-8258

670/9-75-006 PE 1CB047 IN-HOUSE PROJECT

Handbook for Evaluating Water Bacteriology BY E. E. Geldreich, Water Supply Research Laboratory, NERC, EPA Cincinnati, OH

The material included in this Handbook is designed and intended to provide a comprehensive source of information and reference for the evaluation of laboratories involved in bacteriological testing of potable water supplies and their sources. All aspects of the laboratory operation are considered—material and media preparation, equipment needs and specifications, sample collection and handling, bacteriological methodology, quality control considerations, laboratory management, and the qualifications and responsibilities of the survey officer. The purpose of the Handbook is to assist the laboratory survey officer, laboratory director, and senior bacteriologist in charge of the water program to evaluate the many aspects of the laboratory that are involved in attaining reliable data. EPA CONTACT: Geldreich, E. E. 513-684-8414

NEW REPORT ABSTRACTS SECTION

670/9–75–008 PE 1CA046 IN-HOUSE PROJECT

Literature Review and Bibliography of Mammalian Toxicology of Select Munitions BY J. L. Mullaney, and R. G. Tardiff, Water Supply Research Laboratory, EPA Cincinnati, OH

The scientific literature for the past 100 years was researched to obtain a comprehensive review of the biological effects of ten military munitions. The procedure and resulting bibliography were compiled for an evaluation of the reported toxicity and health hazards of these compounds at environmental levels. This bibliography is an expurgated form of the final report performed under a contract with the U.S. Army. Therefore, it should be emphasized that some cited references apply to excluded material since the arrangement of sectional bibliographies was retained in tact. Arrangement of the information was alphabetical by compound name preceded by a general approach to the literature. Substantial published material was retrieved for three of the compounds, pentaerythritol tetranitrate, titanium, and potassium perchlorate. Assuming the toxicity of lead styphnate to be referable to the lead ion, a significant amount of data on the human health hazards of lead styphnate was located. Retrieval for dinitrotoluene, hexachloroethane, nitroguanidine, and potassium chlorate was categorized as primarily supportive toxicity data. Red phosphorus and tetrazene research indicated a paucity of data, very noticeable in their bibliographies. There are 428 references in the bibliography, 292 specific to compound material, 136 general munitions references. EPA CONTACT: Mullaney, J. L. 513–684–8281

680/4–75–004 PE 1HA326 ROAP/TASK 22 AEB IN-HOUSE PROJECT

Nonpoint-Source Pollution in Surface Waters: Associated Problems and Investigative Techniques National Environmental Research Center, EPA Las Vegas, NV

Contaminants entering waterways from diffuse or non-distinct points are termed nonpoint-source pollutants. Principal categories of nonpoint source pollutants in surface waters include sediments, minerals and acids, pesticides, nutrients, organic matter, heat, microorganisms and radioactive materials. Nonpoint source pollutants are generated primarily by such activities as agriculture, silviculture, mining, construction and hydrographic modifications. In terms of volume alone, sediment is the pollutant of greatest significance, and agricultural cropland is the chief contributor. Various models are available for predicting rates and effects of nonpoint pollutants in surface water. Capabilities for predicting sedimentation rates, thermal pollution and mine drainage are fairly sophisticated, but methods for predicting pollution resulting from pesticides, nutrients, heavy metals, biological contaminants and organic wastes are not well refined. Techniques for monitoring nonpoint-source pollutants include manual field sample collection, automated samplers, automatic contact sensors, and to an extent, remote sensing devices. Parameters which can be automatically monitored *in situ* with contact sensors include turbidity, temperature, certain specific ions, specific conductance, pH and dissolved oxygen. Most other parameters must be measured using laboratory analytical procedures. Aerial reconnaissance can be used in a cost effective manner to assess the impact of agriculture, construction mining and silviculture activity on waterways, but quantitative water quality data cannot be reliably produced with remote sensing techniques. EPA CONTACT: Lambou, V. W.

680/4–75–005 PE 1HA327 ROAP/TASK 22 ACW IN-HOUSE PROJECT

Tentative Reference Method for the Measurement of Gross Alpha and Gross Beta Radioactivities in Environmental Waters Quality Assurance Branch, EPA Las Vegas, NV

A tentative reference method for the measurement of gross alpha and gross beta radioactivities in environmental waters is described. Samples of environmental water sources are collected, preserved by acid treatment, and aliquots of the samples are evaporated to dryness in a counting dish and counted for alpha and beta activity. Counting efficiences for sample aliquots are read from curves prepared from counting data of prepared standards, using a known quantity of cesium-137 and 0-10 milligrams of evaporated water dissolved solids per square centimeter of counting dish area for gross beta, and a known quantity of americium-241 and 0–5 milligrams of evaporated water dissolved solids per square centimeter of counting dish area for gross alpha. Results are reported in pCi/liter. EPA CONTACT: Jarvis, A.

680/4–75–006 PE 1FA083 ROAP/TASK 21 AMI IN-HOUSE PROJECT

Tritium Fractionation in Plants BY J. C. McFarlane, National Environmental Research Center, EPA Las Vegas, NV

Alfalfa plants were hydroponically grown in environmental growth chambers in which they were continuously exposed to tritium throughout growth. All segments of the environment were in equilibrium with respect to the specific activity of tritium. The tritium content in plant organic matter was about 22 percent lower than in the plant free water or rooting solution. Under conditions of low transpiration, there was a higher concentration (about 1.8) percent of tritium in the leaves than in the stems and rooting solution. This is thought to represent the result of fractionation during transpiration. EPA CONTACT: McFarlane, J. C.

NEW REPORT ABSTRACTS SECTION

680/4–75–007 PE 1HA327 ROAP/TASK 22 AAJ IN-HOUSE PROJECT

Preliminary Milk Report BY A. N. Jarvis, and D. G. Easterly, National Environmental Research Center, EPA Las Vegas, NV

A summary of the results of the milk cross-check program from July 1973 through November 1974 is given. Examination of these results reveals that 29% of the participants were within the plus or minus 3 sigma control limits for strontium-89 analysis, 42% for the strontium-90, 52% for barium-140, 60% for iodine-131, and 77% for cesium-137. These results indicate the need for improvement in analytical procedures for the radionuclides studies. Accurate analysis of strontium-89 was particularly difficult for most laboratories to achieve, while the accurate analysis of cesium-137 was the least difficult. EPA CONTACT: Jarvis, A. N.

680/4–75–008 PE 1HA326 ROAP/TASK 22 AAE CONTRACT NO. 68–01–0759

Monitoring Disposal-Well Systems BY D. L. Warner, General Electric Company, Tempo, Center for Advanced Studies Santa Barbara, CA BY G. B. Morgan, National Environmental Research Center, EPA Las Vegas, NV

The Environmental Protection Agency is required, under P.L. 92–500, The Federal Water Pollution Control Act Amendments of 1972, to establish a system for the surveillance of the quality of the nation's surface and ground waters. Enactment of P.L. 93–523, the Safe Drinking Water Act, further requires that State programs in order to be approved, shall include monitoring programs to prevent underground injection which endangers drinking water sources. This report provides information concerning the data needed for monitoring the subsurface injection of wastewater through cased disposal wells, and discusses the methods and tools available for obtaining the data. The procedures for using the data for predicting the response of the receiving aquifer to injection are then outlined. Surveillance of operating disposal wells is reviewed. Numerous examples are given throughout the text. EPA CONTACT: Morgan, G. B.

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68-02-1224	650/2-75-069
68-02-1225	650/2-74-059
68-02-1227	600/2-75-024
68-02-1228	650/2-74-121
68-02-1229	650/2-74-120
68-02-1230	650/2-75-056
68-02-1233	650/4-74-043
68-02-1234	650/4-74-005a
68-02-1234	650/4-74-005b
68-02-1234	650/4-74-005c
68-02-1234	650/4-74-005d
68-02-1234	650/4-74-005h
68-02-1234	650/4-74-005m
68-02-1234	650/4-74-005l
68-02-1235	650/4-74-050
68-02-1236	650/2-75-055
68-02-1238	650/4-74-006
68-02-1242	650/4-74-016
68-02-1255	650/2-75-007
68-02-1266	650/1-75-004
68-02-1268	650/2-75-029
68-02-1274	650/1-74-008
68-02-1277	650/1-75-002
68-02-1279	650/2-75-054
68-02-1282	650/2-75-028
68-02-1292	650/2-75-053a
68-02-1292	650/2-75-053b
68-02-1303	600/2-75-015
68-02-1303	600/2-75-017
68-02-1303	650/2-74-079
68-02-1303	650/2-74-114
68-02-1303	650/2-74-124
68-02-1306	650/2-74-085b
68-02-1306	650/2-74-086a
68-02-1306	650/2-74-086b
68-02-1308	650/2-74-028
68-02-1308	650/2-74-072
68-02-1308	650/2-74-098
68-02-1308	650/2-74-116
68-02-1308	650/2-74-127

PROJECT NO.	REPORT NO.
CONTRACTS	
68-02-1308	650/2-74-130
68-02-1308	650/2-75-016
68-02-1308	650/2-75-017
68-02-1308	650/2-75-030
68-02-1308	650/2-75-033
68-02-1309	650/2-75-018
68-02-1310	650/4-74-035
68-02-1314	650/2-75-042
68-02-1316	650/2-74-036
68-02-1316	650/2-74-043
68-02-1316	650/2-74-082a
68-02-1318	600/2-75-046
68-02-1318	650/2-74-091
68-02-1318	650/2-74-123
68-02-1319	600/2-75-042
68-02-1319	650/2-74-033
68-02-1319	650/2-75-065
68-02-1320	600/2-75-045
68-02-1320	650/2-74-021
68-02-1320	650/2-74-041
68-02-1320	650/2-74-082
68-02-1320	650/2-74-117
68-02-1320	650/2-75-019a
68-02-1320	650/2-75-046
68-02-1321	650/2-74-101
68-02-1321	650/2-74-115
68-02-1321	650/2-74-122
68-02-1321	650/2-75-057a
68-02-1321	650/2-75-057b
68-02-1321	650/2-75-057c
68-02-1321	650/2-75-057d
68-02-1323	650/2-74-052
68-02-1323	650/2-74-099
68-02-1323	650/2-74-100
68-02-1323	650/2-75-034
68-02-1323	650/2-75-038
68-02-1324	600/2-75-020
68-02-1324	650/2-74-073
68-02-1324	650/2-75-044
68-02-1324	650/2-75-066
68-02-1325	650/2-74-097
68-02-1325	650/2-74-118
68-02-1325	650/2-75-021
68-02-1328	600/2-75-021a
68-02-1328	650/2-74-112
68-02-1329	650/2-75-032a
68-02-1329	650/2-75-032b

PROJECT NO.	REPORT NO.
CONTRACTS	
68-02-1329	650/2-75-032c
68-02-1339	650/2-74-067
68-02-1348	650/2-74-090
68-02-1352	650/2-74-030
68-02-1353	650/2-74-088
68-02-1363	650/4-74-019a
68-02-1363	650/4-74-046
68-02-1363	650/4-75-011
68-02-1363	650/4-75-013
68-02-1364	600/2-75-014
68-02-1365	650/2-75-060
68-02-1406	650/2-75-026a
68-02-1406	650/2-75-026b
68-02-1436	650/2-75-035
68-02-1438	600/2-75-013a
68-02-1439	650/2-75-064
68-02-1480	650/2-74-129
68-02-1480	650/2-74-129a
68-02-1487	650/2-75-024a
68-02-1496	650/2-75-058a
68-02-1740	650/4-75-024a
68-02-1740	650/4-75-024b
68-02-1752	650/2-75-062
68-02-1753	600/3-75-003a
68-02-1753	600/3-75-003b
68-02-1808	650/2-75-040
68-02-1833	600/4-75-005a
68-02-1851	650/2-75-005a
68-02-1851	650/2-75-005b
68-02-1973	650/2-73-045
68-02-2012	650/2-73-044
68-02-2323	650/2-75-063
68-03-0006	670/2-73-052
68-03-0032	670/2-73-014
68-03-0032	670/2-73-015
68-03-0032	670/2-73-016
68-03-0046	670/2-73-013
68-03-0047	670/5-74-003
68-03-0049	670/2-73-006
68-03-0050	670/2-73-066
68-03-0060	670/2-73-056
68-03-0089	670/2-73-053A
68-03-0089	670/2-73-053A-P
68-03-0089	670/2-73-053B
68-03-0089	670/2-73-053C
68-03-0089	670/2-73-053D
68-03-0089	670/2-73-053E

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CONTRACTS	
68-03-0089	670/2-73-053F
68-03-0089	670/2-73-053G
68-03-0089	670/2-73-053H
68-03-0089	670/2-73-053I
68-03-0089	670/2-73-053J
68-03-0089	670/2-73-053K
68-03-0089	670/2-73-053L
68-03-0089	670/2-73-053M
68-03-0089	670/2-73-053N
68-03-0089	670/2-73-053O
68-03-0089	670/2-73-053P
68-03-0095	670/2-74-019
68-03-0095	670/2-74-020
68-03-0095	670/2-74-021
68-03-0102	670/2-75-045
68-03-0123	670/2-75-024
68-03-0126	670/1-75-001
68-03-0128	670/2-75-023
68-03-0138	670/2-74-078
68-03-0140	670/2-75-049
68-03-0145	670/2-75-014
68-03-0148	670/2-75-038
68-03-0152	600/2-75-035
68-03-0154	670/2-74-033
68-03-0154	670/2-74-045
68-03-0154	670/2-74-086
68-03-0156	670/2-73-086
68-03-0179	670/2-74-040
68-03-0183	670/2-74-037
68-03-0183	670/2-74-038
68-03-0183	670/2-74-065
68-03-0183	670/2-74-066
68-03-0183	670/2-74-068
68-03-0193	670/5-75-001
68-03-0203	670/2-75-012
68-03-0220	670/2-74-056
68-03-0221	670/2-75-007
68-03-0228	670/2-75-004
68-03-0233	660/2-73-026
68-03-0244	670/2-74-095a
68-03-0244	670/2-74-095b
68-03-0260	670/2-74-082
68-03-0262	670/2-74-087
68-03-0262	670/2-75-067
68-03-0268	670/2-74-003
68-03-0272	670/2-75-011
68-03-0283	670/2-74-039

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CONTRACTS	
68-03-0286	600/2-75-041
68-03-0288	660/3-75-024
68-03-0298	660/3-75-018
68-03-0327	670/2-75-066
68-03-0334	600/2-75-038
68-03-0426	600/2-75-027
68-03-0439	660/3-75-037
68-03-0470	600/2-75-040
68-03-2136	660/2-75-011
GRANTS	
AP 01186	650/3-74-003
AP-01269-02	650/2-74-005
EC-00281	670/9-73-035
EC-0030-03	670/2-73-089A
EC-0030-03	670/2-73-089B
EC-00600	670/5-74-002
EP-00242	670/2-74-027
EP-00248	670/2-73-023
EP-00250	670/2-73-063
EP-00254	670/2-73-085
EP-00257	670/2-73-065
EP-00259	670/2-73-072
EP-00261	670/2-73-048
EP-00262-02	670/2-73-009
EP-00265	670/2-73-083
EP-00266	670/2-73-039
EP-00268	670/2-73-061
EP-00274	670/2-73-090
EP-00276-04	670/2-73-005
EP-00279	670/2-73-011
EP-00283	670/2-73-025
EP-00302	670/2-73-051
EP-00304	670/2-73-087
EP-00316	670/2-73-041
EP-00319	670/2-73-034
EP-00328	670/2-73-095
EP-00329	660/2-73-038
EP-00329	670/2-73-038
EP-00329	670/2-75-053
EP-00362	670/2-73-030
EP-00386	670/2-73-049
EP-00393	670/2-73-021
EP-00458	670/5-73-020
EP-00458	670/5-74-001
EP-00500-01	670/2-74-014
EP-00829-01	660/2-74-081
EP-01030	670/5-74-006

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GRANTS	
P5-01-1805	600/1-75-002
UI-00509	670/2-73-057
UI-00557	670/2-73-017
WP 01351-01	660/3-74-014
WP-01322-02	670/2-73-027
WPD 184-01-67	660/2-74-030
WPD-112-01-66	670/2-75-054
WPRD 121-01-68	670/2-73-024
WPRD 16-01-67	670/2-75-037
WPRD 185-01-68	660/2-73-015
WPRD 23-01-68	670/2-73-098
WPRD 242-01	670/2-73-092
WPRD 247-01	670/2-74-061
WPRD 3-01-68	660/2-74-035
WPRD 30-01-0067	670/2-73-096
WPRD 4-01-67	670/2-74-077
WPRD 4-01-67	670/2-75-027
11010 ELP	670/2-73-024
11010 ENK	670/2-73-103
11010 EZQ	670/2-73-098
11010 FLQ	670/2-73-050
11010 FYM	670/2-73-033
11010 GWI	600/2-73-004
11010 DYQ	670/2-75-060
11020 FAM	670/2-74-079
11020 FAN	670/2-73-071
11020 FAX	670/2-75-020
11022 ELK	670/2-74-022
11022 FLV	670/2-75-035
11023 EKC	670/2-75-019
11023 FAR	670/2-75-010
11023 FAS	670/2-73-067
11024 EVF	600/2-73-002
11030 HJP	670/2-74-096
11060 DRO	660/2-73-038
11060 FRQ	600/2-75-030
11060 GVT	670/2-74-062
12010 DNP	660/2-74-050
12010 DOT	670/2-74-059
12010 DRH	660/2-73-033
12010 DSA	670/2-74-042
12010 FNM	660/2-73-032
12010 FXD	670/2-75-018
12010 GUG	600/2-75-028
12020 ERM	670/2-74-044
12040 DER	660/2-74-069
12040 DRY	660/2-74-008
GRANTS	
12040 EJU	660/2-75-004
12040 GQD	660/2-73-028
12040 HDU	660/2-74-086
12050 GTR	660/2-75-020
12060 DFF	660/2-74-027
12060 DQV	660/2-73-015
12060 EGV	660/2-74-031
12060 EIG	660/2-74-088
12060 EKQ	660/2-74-012
12060 ESC	660/2-74-093
12060 ESY	660/2-74-035
12060 FAK	660/2-74-028
12060 FLL	660/2-74-014
12060 FRW	660/2-73-020
12060 FRW	660/2-73-021
12060 FYG	660/2-74-060
12060 HCW	660/2-74-059
12060 HFY	660/2-74-092
12060 HNG	660/2-74-046
12060 HPC	660/2-75-002
12070 HEK	660/2-73-023
12080 GCH	660/2-74-040
12090 HLO	660/2-74-039
12110 GLP	660/2-73-018
12120 FYV	660/2-73-037
12120 GLE	660/2-74-007
12120 HMZ	660/2-75-006
12130 DBF	660/2-73-010
12130 EKK	660/2-74-020
12130 HFX	660/2-73-036
12130 HRA	660/2-74-055
13020 DTV	660/2-74-005
13020 DWH	660/2-74-033
13020 EBL	660/2-74-032
13040 DFN	660/2-74-030
13040 ERR	660/2-74-009
13040 EVM	660/2-74-047
13040 FYK	660/2-74-057
14010 EFJ	670/2-73-092
14010 EFL	670/2-73-054
14010 EFN	670/2-73-093
14010 HQC	670/2-74-009
14020 EHW	660/2-74-019
14020 FVW	660/2-74-037
14040 FVD	660/2-74-018
14040 FZC	670/2-73-080
15010 PBK	670/2-73-088

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GRANTS	
15020 HKQ	670/2-74-063
15030 FMZ	660/2-73-035
15030 HIX	660/2-74-043
15080 EJQ	670/2-73-099
15080 HET	670/2-73-068
16010 DBU	660/3-74-034
16010 DCK	660/3-73-002
16010 DFI	660/3-73-001
16010 DHN	660/3-73-003
16010 EDJ	660/3-73-006
16010 EJH	660/3-73-015
16010 ELF	660/3-74-017
16010 EQQ	660/2-74-010
16020 DHD	670/2-73-079
16020 EDG	660/2-74-021
16020 EGG	660/3-74-026
16020 GIY	670/4-74-004
16030 ELZ	660/2-73-027
16040 FRL	660/2-73-008
16050 DDK	660/3-73-009
16050 DIL	660/2-74-082
16050 DIL	660/2-74-083
16050 DIL	660/3-73-011
16050 DXM	660/3-73-008
16050 ESP	660/3-74-002
16050 GQQ	660/3-73-025
16070 DEP	660/3-74-004a
16070 DEP	660/3-74-004b
16070 DGO	660/3-75-025
16070 DGY	660/3-73-010
16070 EKZ	660/3-73-005
16070 FBY	660/2-73-029
16080 DYJ	660/2-74-016
16080 FBH	660/2-73-022
16080 FWE	600/2-74-003
16080 FYW	660/2-73-025a
16080 FYW	660/2-73-025b
16100 FWQ	660/3-73-018
16100 PAK	660/2-73-017
16110 GEW	600/5-74-013
16130 FDQ	660/2-73-012
16130 GNK	660/2-73-011
16130 GSD	660/2-73-003
16130 HKK	660/2-73-004
17010 EBM	670/2-73-027
17020 EPF	670/2-74-012
17030 DMA	670/2-73-074
GRANTS	
17030 DUW	670/2-74-047
17030 EBH	600/2-75-039
17040 DSR	670/2-74-077
17050 DBI	670/2-74-018
17050 DFJ	600/2-75-032
17050 EEY	670/2-74-048
17060 DNU	670/2-73-029
17060 EYZ	670/2-73-082
17070 HDA	670/2-74-004
17080 FSF	670/2-73-064
17080 HHV	670/2-74-080
18050 DET	660/3-74-003
18050 DFQ	660/3-73-016
18050 DIJ	660/3-73-020
18050 DMB	660/3-73-017
18050 DPL	660/3-73-019
18050 ELT	660/3-74-006
18050 FLS	660/3-73-004
18080 DFU	660/3-74-014
18080 FBW	660/3-74-031
800042	650/2-75-002
800055	660/2-73-032
800055	670/2-73-032
800055	670/2-74-083
800055	670/2-74-084
800150	650/2-74-034
800209	650/3-75-005
800250	660/2-74-091
800261	660/2-73-019
800278	660/2-74-052
800278	660/2-74-084
800294	660/2-75-014
800312	660/2-75-017
800316	650/2-74-110
800351	670/2-74-032
800354	600/2-75-029
800356	670/2-75-039
800364	660/2-75-009
800365	660/3-75-013
800369	660/3-73-009
800373	660/3-74-016
800397	650/4-74-032
800397	650/4-74-045a
800397	650/4-74-045b
800400	660/2-74-005
800401	660/2-74-033
800426	660/2-74-049

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PROJECT NO.	REPORT NO.
800432	670/2-75-033a
800432	670/2-75-033b
800432	670/2-75-033c
800432	670/2-75-033d
800435	660/3-75-014
800504	660/3-75-027
800510	660/3-73-022
800536	660/3-75-021
800602	670/2-74-030
800605	660/3-75-004
800608	660/3-75-022
800609	660/3-75-006
800610	660/3-75-005
800613	660/2-73-012
800613	660/2-74-085
800613	660/3-75-002
800613	660/3-75-038
800650	670/2-74-013
800650	670/2-75-056
800652	670/2-74-015
800662	600/4-75-004
800662	650/4-75-015
800674	670/5-74-004
800677	650/3-75-003
800678	660/2-74-003
800680	660/2-73-024
800685	670/2-73-060
800688	670/2-75-031
800704	660/3-75-017
800707	670/2-73-022
800731	660/2-75-008
800736	660/3-74-025
800745	670/2-74-070
800746	660/2-74-046
800747	660/2-74-025
800766	660/2-75-021
800766	670/2-74-016
800767	660/2-74-063
800769	670/2-74-075
800778	660/3-74-028
800781	600/2-75-023
800786	670/2-75-040
800798	600/2-75-019
800842	650/2-74-011
800845	650/3-75-006
800853	660/2-74-029
800854	660/2-74-071

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PROJECT NO.	REPORT NO.
800857	600/2-74-009a
800857	600/2-74-009b
800857	600/2-74-009c
800866	650/2-73-011
800869	650/2-75-067
800904	660/2-74-061
800909	660/2-74-004
800916	650/3-75-011
800921	660/2-74-048
800923	660/2-75-013
800935	660/2-74-074
800938	670/2-75-030
800941	670/2-75-046
800943	660/2-74-053
800949	650/3-75-008
800950	650/2-74-095
800966	670/2-74-049
800989	660/3-74-027
800991	660/2-74-079
800994	660/3-74-033
800997	660/2-73-002
801000	600/5-74-022
801003	660/3-75-003
801029	660/2-73-027
801036	660/3-74-007
801039	660/3-73-018
801040	660/2-75-005
801062	660/3-74-029
801065	660/2-74-090
801113	650/4-75-012
801120	650/4-74-004
801124-03	660/3-75-026
801136	650/3-74-006
801159	670/2-74-057
801174	650/3-74-011
801207	660/2-73-030
801226	600/5-74-027
801234	600/5-74-011
801236	670/2-75-006
801282	670/2-74-076a
801282	670/2-74-076b
801289	670/2-74-035a
801289	670/2-74-035b
801289	670/2-74-036a
801289	670/2-74-036b
801303	670/2-73-091
801321	650/2-73-020

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GRANTS	
801336	650/2-75-036
801340	650/3-74-007
801342	670/2-74-031
801343	660/3-74-020
801349	670/2-75-016
801361	660/3-73-023
801362	660/3-73-024
801363	660/3-75-033
801374	600/5-73-016
801376	600/5-73-015
801381	660/3-75-030
801393	650/1-74-010
801397	600/2-75-043
801400	660/2-75-007
801411	600/5-74-020
801417	660/2-74-077
801419	600/5-75-003
801432	660/2-75-001
801446	650/2-74-007
801454	660/2-75-003
801454-01	660/2-74-024
801470	650/1-74-012
801473	600/5-73-012a
801473	600/5-73-012b
801473	600/5-73-012c
801473	600/5-73-012d
801473	600/5-73-012e
801481	600/5-74-029
801484	660/2-74-006
801490	650/2-73-014
801500	600/5-74-024
801521	600/5-73-007
801522	600/5-73-011
801577	660/2-74-094
801603	650/2-74-063
801615	650/2-74-027
801622	670/2-75-034
801628	600/2-74-005
801630	670/2-74-094
801633	670/2-75-026a
801633	670/2-75-026b
801647	660/2-74-034
801650	650/1-74-011
801658	670/2-73-043
801662	660/2-74-064
801666	660/2-74-068
801673	600/5-75-010

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801678	670/2-74-024B
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801799	670/2-75-061
801799	670/2-75-062
801799	670/2-75-063
801799	670/2-75-064
801830	670/2-74-073
801835	660/2-74-054
801867	660/2-75-027
801870	670/5-74-007
801870	670/5-74-008
801870	670/5-74-009
801872	670/2-75-043
801876	660/2-74-044
801944	670/2-75-032
801945	650/4-74-041
802003	600/2-75-031
802005	650/1-74-002
802009-01	660/2-74-023
802032	660/2-74-011
802043	650/1-75-003
802084	660/2-75-028
802113	670/2-75-055
802168	660/2-75-026
802174	660/2-75-019
802205	660/2-75-012
802219	670/2-74-026
802219	670/2-75-022
802254	670/2-73-104
802254	670/2-74-008
802269	650/2-74-080
802270	650/2-74-051
802291	650/2-74-048
802310	600/2-75-007a
802310	600/2-75-007b
802348	660/3-75-015
802366	650/2-75-012
802400	670/2-75-021
802402	650/2-74-032
802411	670/2-75-017
802419-01	650/2-74-096
802423	600/5-75-008
802424	600/2-75-025
802441	600/5-73-009
802443	600/5-75-005
802443	600/5-75-009

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802614	670/2-74-023
802621	670/2-75-048
802637	670/2-75-015
802716	670/2-75-041
802726	650/2-75-043
802781	600/2-75-033
802926	600/2-74-008
802980-01	660/4-75-002
803021	660/2-75-010
803026	660/2-75-025
803046-01	600/2-75-005
803056	600/5-75-012
803063	670/2-75-044
803063	670/2-75-059
803063-01	670/2-75-003
803069	670/2-75-065
803111	670/2-75-058
803226-01	670/2-75-029
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IAG D4-0446	660/2-75-015
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IAG-D4-0377	650/2-75-048
IAG-D4-0454	650/2-75-011
IAG-097(D)	650/2-75-014
IAG-134(D)	600/2-75-006
IAG-141(D)	660/3-75-011
IAG-148	600/5-75-013
IAG-148(D)	600/5-75-002
IAG-152(D)	660/3-75-010
IAG-323	650/3-74-005
IAG0020(D)	650/2-74-038
IAG0077(D)	650/2-74-113
IAG0085(D)	650/2-73-006
IAG0134(D)	650/2-73-051
IAG0139(D)	650/2-74-070
IAG0149(D)	650/2-74-104
IAG0177(D)	650/2-73-034
IAG0199(D)	650/2-74-057
IAG0215	650/2-74-125
IAG085(D)	650/2-75-004

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IAG31990A	650/2-74-049a
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IAG40377(D)	650/4-74-030
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